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(6) **NOISECHECK PROCEDURES FOR MEASURING NOISE EXPOSURE FROM AIRCRAFT OPERATIONS.**

(10) DWIGHT E. BISHOP
ANDREW S. HARRIS
JOAN MAHONEY
PETER E. RENTZ
BOLT BERANEK AND NEWMAN INC.
10 MOULTON STREET
CAMBRIDGE, MA 02238

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AIR FORCE AEROSPACE MEDICAL RESEARCH LABORATORY
AEROSPACE MEDICAL DIVISION
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

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AFAMRL-TR-80-45

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FOR THE COMMANDER

Henning E. von Gierke

HENNING E. VON GIERKE, Dr. Eng.
Director
Biodynamics and Bioengineering Division
Air Force Aerospace Medical Research Laboratory

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NOISEMAP	Sound Exposure Level (SEL)
NOISEFILE	Aircraft Environmental Noise

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

NOISECHECK is a measurement program used (1) when an engineer is uncertain about a Sound Exposure Level (SEL) resulting from a particular type of operation or (2) to check noise contours determined by NOISEMAP — an Air Force computer program. The file of aircraft noise data used by NOISEMAP is called NOISEFILE. The NOISECHECK measurement program uses portable noise monitors that measure Day-Night Sound Levels (DNLs) over one or more days as well as individual Sound Exposure Levels (SELs). (continued)

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Block 20. Abstract (cont'd)

The measured DNLs are then compared with the DNLs calculated by NOISEMAP, or they contribute SEL data for comparison with NOISEFILE. This report delineates the field test data acquisition and analysis procedures used to conduct NOISECHECK type measurement studies. A companion report, AMRL-TR-78-125, Development of NOISECHECK Technology for Measuring Aircraft Noise Exposure, describes the instrumentation development and subsequent field test conducted at Barksdale AFB as part of this research effort.

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SUMMARY

PROBLEM

Aircraft noise contours are normally produced by using an Air Force computer program called NOISEMAP. Sometimes, however, the data produced by NOISEMAP are questioned, or an engineer may be uncertain about noise levels that result from a particular type of aircraft operation. For these cases, a procedure must be developed to check the accuracy of NOISEMAP and call attention to incomplete or uncertain data.

APPROACH

This report presents NOISECHECK – a procedure to refine and check the accuracy of NOISEMAP through the use of noise measurements. Section 1 describes a variety of situations that may cause uncertainties in the noise values calculated by NOISEMAP as well as a number of reasons for inaccuracies inherent in NOISEMAP. It also presents a flow diagram of the steps involved in NOISECHECK.

Section 2 describes in detail how to plan a noise measurement program. It includes details for establishing a program goal, assembling NOISEMAP background material, estimating the length of a measurement program, selecting measurement locations, obtaining instrumentation, and holding a protocol meeting.

Section 3 presents procedures for conducting a field measurement program. The program consists of the 7 following elements:

- Maintenance of Tower Logs
- Maintenance of ground runup logs
- Maintenance of weather logs
- Installation of instruments
- Servicing of instruments
- Preparing photographic documentation
- Analyzing in-field data.

Checklists are presented for installing and servicing in-field noise-monitoring equipment.

Section 4 describes the analysis of the field data. Procedures are described for analysis of Day-Night Levels (DNLs) measured directly and for synthesis of DNLs from Sound Exposure Levels (SELs). The analysis involves 6 worksheets, each with step-by-step instructions; some worksheets also have supplemental calculations. The final analysis is an evaluation of the probability that the measurements and NOISEMAP are consistent.

Section 5 presents a method for determining contributions to NOISEMAP DNL values at specific sites. The method uses data from the NOISEMAP data base, NOISEFILE, and from airbase operations information to obtain an SEL value and a partial DNL value for each operation. The partial DNLs are summed until the total is within 0.3 dB of the NOISEMAP DNL for the site. Significant operations are all operations contributing to that total.

PREFACE

This research program was performed for the Air Force Aerospace Medical Research Laboratory at Wright-Patterson Air Force Base, Ohio under Project/Task 723107, Technology To Define and Assess Environmental Quality of Noise From Air Force Operations. Technical Monitor for this effort was Mr. Jerry Speakman of the Biodynamic Environment Branch, Biodynamics and Bioengineering Division.

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1. INTRODUCTION

This manual contains all the information needed to understand and implement NOISECHECK, a program designed to

- Measure noise levels at ground locations in or near Air Force bases, and

- Use these measurements to make annual Day-Night Sound Level* (DNL) estimates of predictable accuracy.

NOISECHECK estimates can be used for comparison with DNL values developed by the Air Force NOISEMAP program, which is used to calculate the exposure of communities to the noise of aircraft. Though the NOISECHECK program is useful in any situation where measurements of aircraft noises are important - such as a suspected noisy area where new construction is planned or an area that may be newly impacted by a change in operations - it is designed for use specifically when a NOISEMAP DNL is questioned or challenged.

Most of the questions about NOISEMAP that require resolutions by NOISECHECK are caused by inaccurate or mistaken inputs to NOISEMAP. Examples are:

- Actual numbers of operations (frequencies) per day and night period are different from those assumed in the NOISEMAP computations;

- Actual aircraft flight tracks over ground are different from those assumed;

- Aircraft missions or flight profiles and engine power settings are different from those assumed;

- Types of aircraft using various flight tracks are different from those assumed;

- Actual noise levels differ from those in the NOISEFILE data base used by NOISEMAP;

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*Day-Night Sound Level: the A-weighted sound level averaged on an energy basis over 24 hours with a +10 dB weighting average applied between 2200 and 0700 hours. Yearly average Day-Night Sound Level: the energy-averaged daily DNL value for the year.

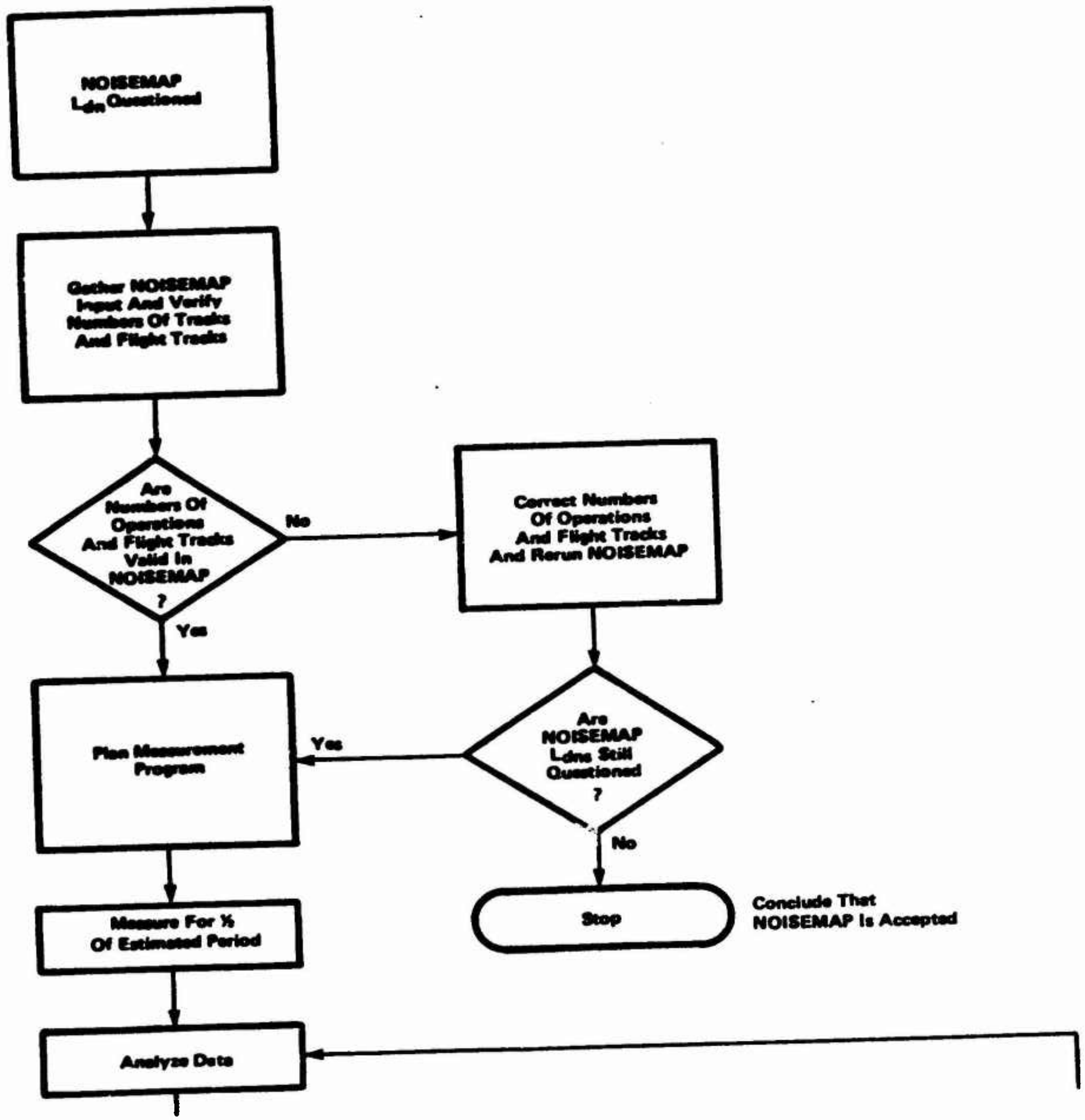
* Actual average weather conditions cause significantly different attenuation from those assumed;

* Ground runup operations (locations, orientations, power settings, or durations) are different from those assumed.

Other possible causes are background noise, local features, and inaccuracy in NOISEMAP algorithms. For example, background noise from other sources may be causing significantly higher noise levels than those caused by aircraft alone. Some local geographic feature, such as a hill, may be known but is not taken into account in NOISEMAP calculations (which assume a flat terrain around the airbase and its flight paths). Finally, inaccuracies or uncertainties in various NOISEMAP algorithms, such as takeoff roll, model for transition from air-to-ground to ground-to-ground propagation conditions, or excess sound attenuation, may be important.

Figure 1 is a flow diagram of NOISECHECK procedures.

Appendix A contains three log sheets: one for the tower, one for runups, and one for the weather. Appendix B includes four checklists: one each for the tower and runup logs, one for initial installation of the portable noise monitor, and the fourth for service visits to the portable noise monitor. Appendix C contains all worksheets for data analysis.



NOISEMAP
Ldn Questioned
Gather NOISEMAP
Input And Verify
Numbers Of Tracks
And Flight Tracks
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Yes
No
Plan Measurement
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Conclude That
NOISEMAP Is Accepted
Measure For ½
Of Estimated Period
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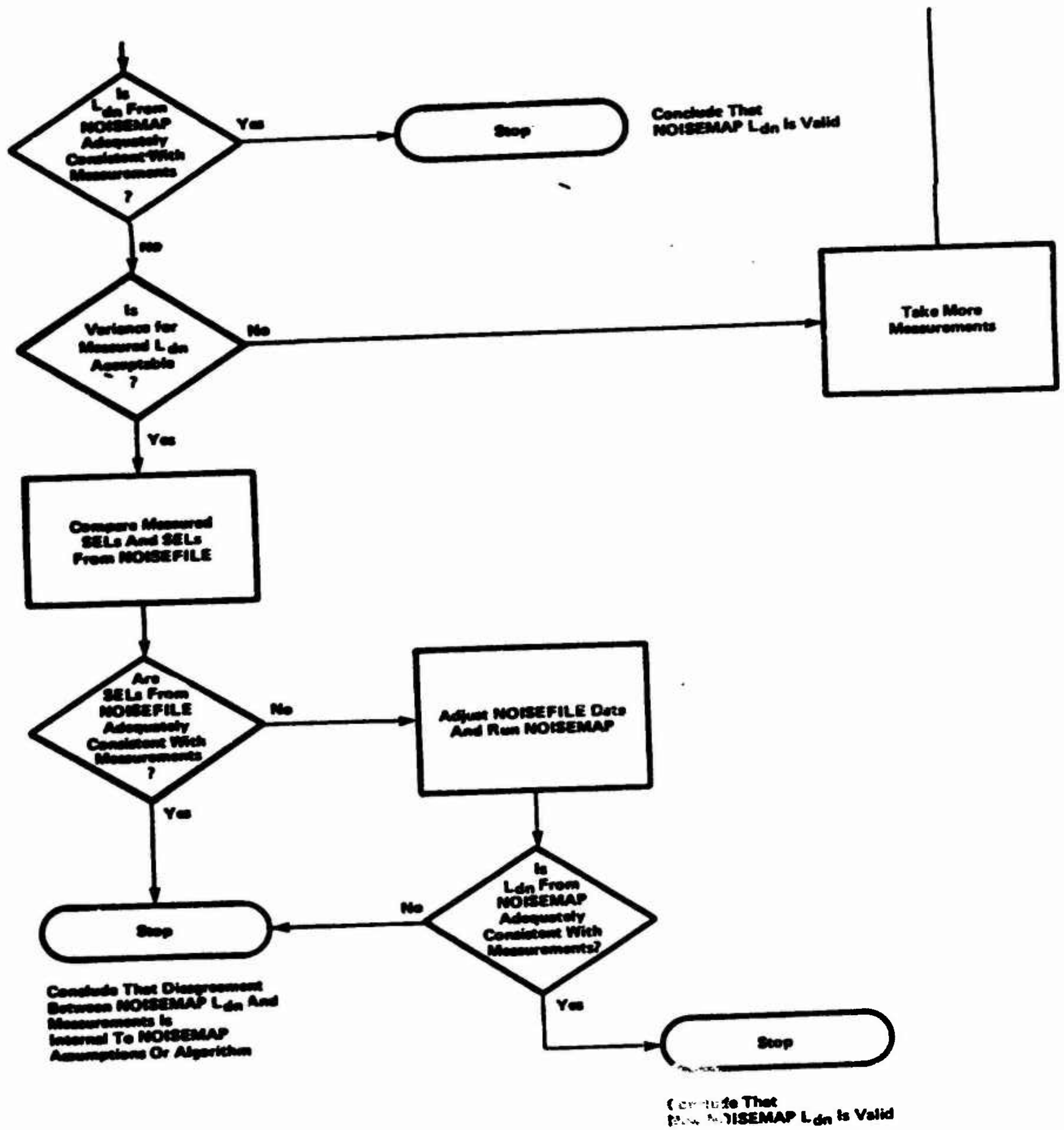

FIG. 1. FLOW DIAGRAM OF NOISECHECK PROCEDURES.

2. NOISECHECK: FIELD MEASUREMENTS PLANNING AND PREPARATION

The first step in planning any field-measurement program is to choose the appropriate program goal. Once this decision is made, planning steps include:

- Assembling NOISEMAP contours and chronicles
- Estimating the length of the measurement program
- Selecting measurement locations
- Obtaining recommended instrumentation
- Holding a protocol meeting.

DEFINING PROGRAM GOAL

Defining the program goal requires that the engineer determine the location or area where NOISEMAP values of DNL have been questioned.* Then move on to the other planning steps.

ASSEMBLING NOISEMAP CONTOURS AND CHRONICLES AND VERIFYING OPERATIONS

The NOISEMAP contours and chronicles contain information vital to all measurement programs (although up-to-date contours may not be available at some airbases). This information, including DATASCREEN† operational summaries, should be assembled for use during planning as well as during analysis and critiquing of results.

All field tests require DNL contours, types of aircraft, operational frequencies, information on ground runups, and flight track plots. Aircraft power-altitude-flight-track listings are a requirement for critiquing results involving SEL measurements.

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*Field measurements may have a lesser goal – definition of the SEL for one or more types of operation. The procedures for program planning measurement and analysis of SELs would follow the guidance of Secs. 2 through 4 of NOISECHECK; however, they would conclude before synthesis of DNL.

†The DATASCREEN is a separate computer program that provides an analysis of NOISEMAP input in terms of a summary of aircraft operations by type of aircraft and by runway as well as aircraft types by runup pad.

Since many errors in NOISEMAP values of DNL are the result of errors in operations input data (numbers or types of operations) or flight tracks, these sets of input should be reviewed with base personnel before proceeding to plan and implement a measurement program. Should significant* input errors be found, NOISEMAP should be rerun with the new input.

ESTIMATING THE DURATION OF THE MEASUREMENT PROGRAM

Although one might desire to determine the exact duration of a measurement program before the start of the program, such forecasts may be very inaccurate. At any given location, the length of the measurement period is a function of the variability of the data being measured. For example, DNL will tend to be stable at a location close to a runway end where the frequency and mix of operations are nearly constant. However, DNL will be less stable at points at greater distances from runways or near airbases where the frequency or mix of operations varies significantly.

If the daily number of operations for each major noise contributor is predicted to be at least 75% of the average busy day level from the NOISEMAP chronicle, DNL can be measured directly, and the length of the period needed to measure the site DNL can be estimated by the following steps:

1. First, estimate the approximate sample standard deviation in daily DNL values, using Fig. 17 on page 58. In using this chart, consider only the operations that contribute most to the site DNL.†

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*Significance of errors can be determined by using NOISEFILE data and the method described in Sec. 5 for determination of the primary contributors to the DNL at a site.

†Note that this estimate requires a determination of the operations (and flight tracks) that influence the site noise environment. Procedures described in Sec. 5 may be used to estimate the contribution of each type of operation to the site DNL.

2. Second, use the approximate sample standard deviation to enter Fig. 2, "Number of Measurements Needed to Assure a 90% Confidence Interval."*

For DNL measurements, use Fig. 2 to determine the number of days of measurements for a 90% confidence interval. Select the number of days to determine the confidence interval to be at most ±2 dB, and, preferably, ±1.5 dB.

If the daily number of operations for each major noise contributor is predicted to be less than 75% of the average busy day or the measurement period from the first estimate appears too long, SELs must be measured. The number of measured SEL values required for a given type of operation should then be estimated.

If SEL measurements are to be made, estimate the number of measurements using Fig. 2 and Fig. 17. The standard deviation shown in Fig. 2 can be derived by taking the square root of the variance in Fig. 17. The number of measurements is then obtained from Fig. 2, aiming for a confidence interval of ±1 dB for the major SEL contributors to the site DNL, and a ±2-dB confidence interval for lesser SEL contributions (i.e., contributors whose "partial" DNL values are likely to be within 10 dB of the site DNL).

When the significant operations have been identified and the period has been estimated, the engineer should verify with the Base Operations office that the required operations will occur during the intended measurement period.

SELECTING MEASUREMENT LOCATIONS

Specific measurement sites should be chosen after a general inspection of the area to be surveyed. Sites should be selected to provide the required noise information (e.g., verification of SEL, or DNL, at a point of concern) and also to meet three general measurement criteria: security of the portable noise monitoring systems, a background noise level that is low in relation to the aircraft noise levels, and no acoustic interferences.

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*Figure 2 is based upon the arithmetic mean and the standard deviation about the arithmetic mean. In later calculations using measured data, confidence intervals are determined for the energy average of measured levels, a more rigorous calculation procedure. However, Fig. 2 is sufficient for initial measurement planning purposes.

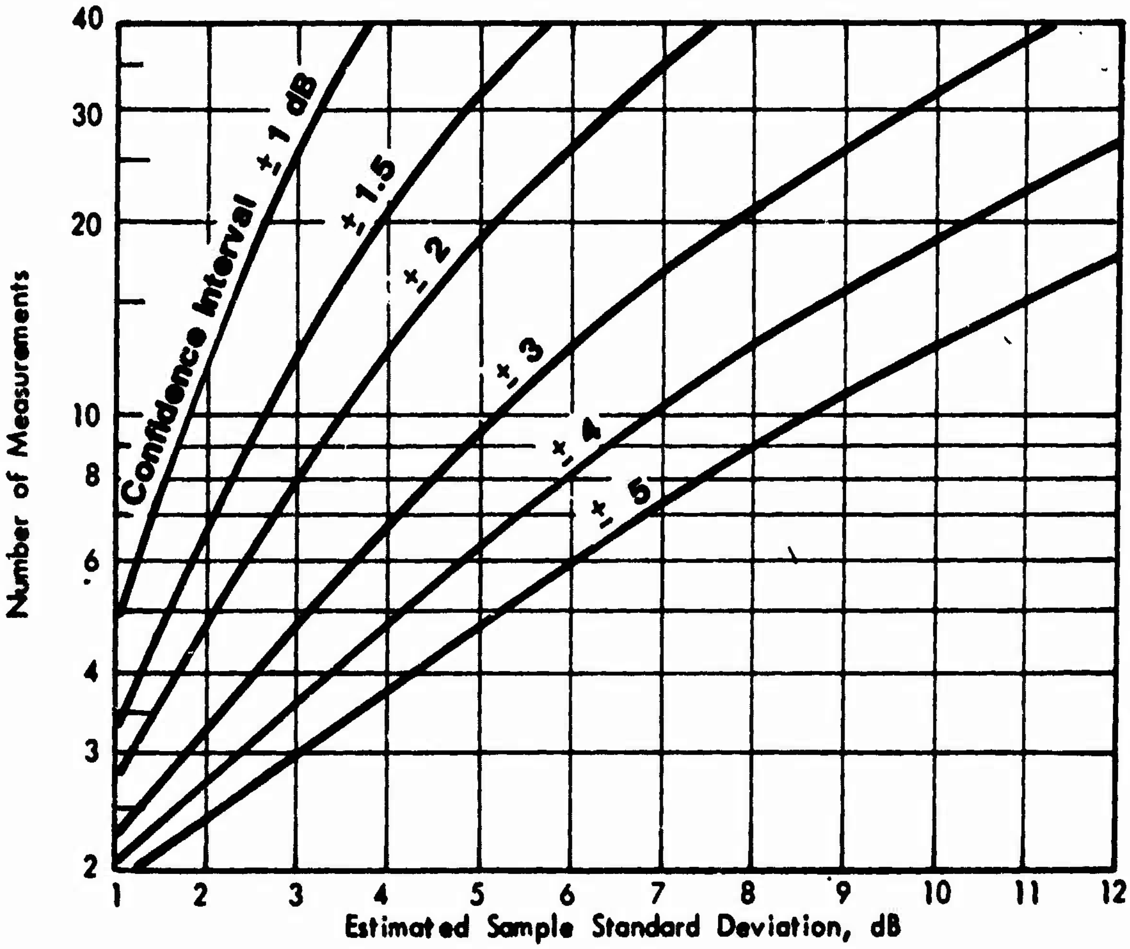

FIG. 2. NUMBER OF MEASUREMENTS NEEDED TO ASSURE A 90% CONFIDENCE INTERVAL.

Where an area is to be surveyed, rather than a single, small site, a group of measurement points should be selected. One site would be the primary or "key" site. Others would be the secondary or "satellite" sites. The key site would be used for the entire set of measurements in an area and the satellite site or sites for shorter-term measurements (i.e., to help determine noise gradients over an area).* The engineer charged with placement of the noise monitoring systems should seek maximum protection for the units. The best choice is to locate the units inside a building that can be locked or guarded, with a cable leading to an outside microphone. A less preferable method is to place the system in an enclosed area, with the noise monitor chained to a post (Fig. 3) or in the open, also with the unit chained to a tree or fence post. Least desirable is placement of the unit in the open, unchained.

Noise monitors should be located in areas of low background noise, away from or shielded from roads. Be aware, however, that background noise may still be a problem at measurement sites where aircraft noise levels exceed background sound levels by only 10 dB or less.

"Acoustic interferences" include line-of-sight obstructions and reflecting surfaces. No object, even a tree, should obstruct the line of sight between the microphone and the aircraft at the point of closest approach. The microphone should not be placed within 100 ft of a vertical flat reflecting surface that is perpendicular to the plane of the microphone and aircraft at the point of closest approach, with one exception - in residential neighborhoods, reflecting surfaces are an unavoidable part of the acoustic environment.

One task in the selection of measurement sites may be obtaining from civilian owners permission to use a site that is outside airbase property. Such permission may be obtained verbally by the engineer, either in person or by a telephone call.

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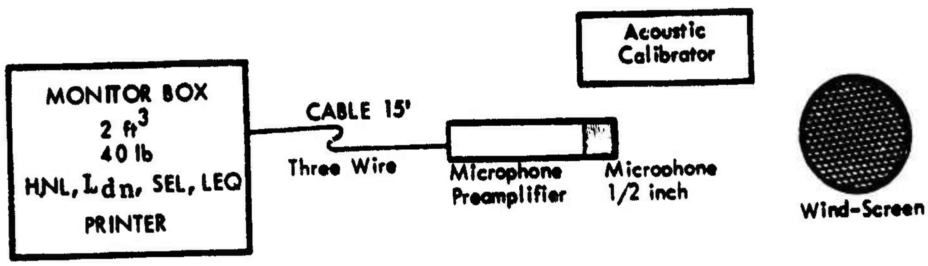
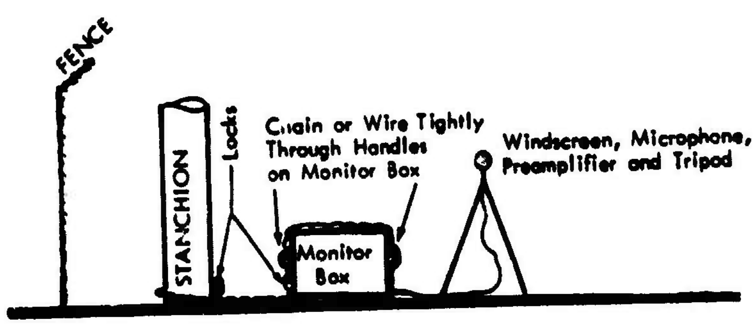
*If a very large area is to be verified (e.g., definition of the DNL 65 contour in a town), a number of key sites will be required.



SYSTEM BLOCK DIAGRAM



SYSTEM INSTALLATION

FIG. 3. PORTABLE NOISE LEVEL MONITOR SYSTEM COMPONENTS AND TYPICAL SYSTEM INSTALLATION.

INSTRUMENTATION

NOISECHECK programs involve a basic noise monitoring unit: Digital Acoustics DAI 607P, which consists of a standard sound level meter with built-in digital computing and memory capabilities and a printer. This unit can process, store, and print out either single-event or continuous noise exposure data. Printout of HNL, DNL data, etc., can be on demand or at specified intervals. Figure 3 shows the components of the system and a recommended installation.

The microphone is a GenRad 1962-9601, an electret form of a condenser-type microphone. These microphones were chosen for NOISECHECK programs because they have moderate sensitivity and excellent frequency response, and they can tolerate a wide range of operating conditions. A microphone windscreen of porous foam is provided not only to reduce the noise of wind but also to protect the instrument from rain and snow.

The system calibrator is a GenRad 1567.

Because the electrical signals generated by the microphone are small, it is attached directly to a preamplifier - a stable, low self-noise electrical amplifier that transmits the enhanced electrical signal over a cable to the DAI 607P.

The digital circuitry of the DAI 607P samples the electrical signal that would be fed to an indicating meter in a standard sound level meter 8 times a second and then uses these sampled levels in digital computations. DAI output is in two forms: an LED display for visual observation and printouts on a thermal printer for permanent records.

The DAI 607P has been designed for routine output of the DNL used for aircraft noise analyses. It also measures and prints out the HNL as well as the SEL and maximum A-level of individual noise events that rise above a selectable noise threshold. Incorporated in the unit is an accurate time clock, which records the time of day at which single events occur. The DAI 607P has the option to output percentile distribution functions of the measured A-level over specified time intervals, data which can be used for nonaircraft noise analyses.

See AMRL-TR-78-125, Development of NOISECHECK Technology For Measuring Aircraft Noise Exposure, for more detailed information concerning the monitor itself.

PROTOCOL MEETING

An important step in the planning of field measurements is a protocol meeting, at which the engineer can discuss with airbase personnel the support requirements he will need during the NOISECHECK program and, if necessary, change or adapt them to conform to base resources. The meeting should be with the Base Commander and should include, but not be limited to, representatives of the following areas: Base or Wing Operations, Civil Engineering, Environmental Health, Tower Operations, Weather Station, and Maintenance.

The basic roles of each department participating in a NOISECHECK program are described in this paragraph. The Base Commander is responsible for overall coordination of base activities and needs to be aware of any NOISECHECK program. The engineer will rely on personnel from Base or Wing Operations for forecasts of operations. (The engineer must make sure that the Base Commander and Operations Office understand the importance of normal flight and ground runup operations during the measurement period.) Civil Engineering is responsible for the Base AICUZ program and the NOISEMAP contours; the engineer responsible for NOISECHECK must rely on Civil Engineering for information on the NOISEMAP input used for the contours that have been questioned. Also, Civil Engineering will use the results of the NOISECHECK program. Environmental Health will normally be called upon for manpower support during NOISECHECK. Tower Operations, the Weather Station, and Maintenance will be asked to keep logs of air operations, the weather, and maintenance (ground runup) operations, respectively, during NOISECHECK measurements.

This review concludes the basic planning for NOISECHECK. At this point, the engineer will have concluded what measurements are necessary, estimated how long the program will take, and coordinated the program with base personnel. Section 3 is a guide for the engineer as he makes actual measurements.

3. CONDUCTING NOISECHECK FIELD MEASUREMENTS

In the field, a NOISECHECK program includes 7 elements:

- Maintenance of Tower Logs (by tower personnel)
- Maintenance of Ground Runup Logs (by maintenance personnel)
- Maintenance of Weather Logs (by weather personnel)
- Initial installation
- Servicing units
- Photographic documentation
- In-field data analysis.

MAINTENANCE OF TOWER LOGS

A NOISECHECK field measurement program involves the assistance of flight control tower personnel, who must log aircraft operations on a Tower Log form (Fig. 4) throughout the program.*

Before turning the log forms over to the tower personnel, the engineer should list the aircraft contributing to the exposure in the measurement area.† (The form has space for listing 7 different types.) The engineer should use the NOISEMAP chronicles and/or DATASCREEN summaries with flight track paths to identify the more important aircraft and flight or runup operations influencing the DNL values at the proposed microphone sites. He should make sure that the form is set up so that the operations are described in the same way tower personnel describe them.

The engineer should give a copy of the following 7-step log procedure to flight control tower personnel, should review it with them, and should answer any questions about it before proceeding with the next step.

---

*Log sheets are contained in Appendix A.

†The procedures described in Sec. 5 can be used to determine operations that contribute to exposure.

Installation ____________________
Date ____________________
Runway(s) ____________________

TIME	AIRCRAFT							OPERATIONS				
							Other	Runway	T/O*	Approach†	T & G	Other

*Takeoff SO - Straight Out R - Right Turn Departure
P - Pattern L - Left Turn Departure

†Approach SI - Straight In
P - Pattern

FIG. 4. AIRCRAFT TOWER LOG FORM.

Aircraft Tower Log Procedure*

1. Log every aircraft movement that affects the measurement area.

2. Use check marks for aircraft types listed. Identify others.

3. Describe the aircraft operation with the code letters listed at the bottom of the form. Note that for touch-and-go or flyby operations, entries are required for both approach and takeoff. Include under "comments" the flight track identifications.

4. List the time at which the aircraft passes the tower.

5. Begin a new sheet at start of new duty day (midnight).

6. Note any runway changes at the time of change.

7. Indicate under "comments" if the practice pattern was radar controlled (R) or visually controlled (VFR).

MAINTENANCE OF GROUND RUNUP LOGS

If ground runups influence the exposure in the area of interest logs of these runups must be kept. Maintenance personnel will assist in the program by keeping the logs. Figure 5 shows a sample log.

The engineer should give a copy of the following 4-step log procedure to maintenance personnel, should review it with them, and should answer any questions about it before proceeding with the next step. The log should describe in detail the ground runup power setting-duration values (e.g., 5 min @ afterburner, 8 min @ MIL PWR, 8 min @ 80% rpm, and 20 min @ idle).

Aircraft Maintenance and Runup Log Procedure

1. Log every maintenance runup.

2. Use a separate sheet each day for each runup pad or test cell.

---

*Appendix B contains copies of the four checklists presented in the text.

Measurement Program ___________

Sheet___ of ___

Installation _______________

Date _______________

Runup Pad
or Test Cell _______________

Aircraft Type	Aircraft Orientation on Runup Pad	Power Setting	Time: Start to Setting	Time: End at Setting	Total Time at Setting	Comments

FIG. 5. AIRCRAFT MAINTENANCE LOG.

3. List the power setting for each test segment as well as the start time and end time at that setting (hours, minutes, seconds).

4. Indicate under "comments" any unusual occurrence during a runup.

MAINTENANCE OF WEATHER LOGS

The third element of a NOISECHECK field measurement program – Maintenance of Weather Logs – also involves the assistance of base personnel. These logs are kept by the staff of the Weather Office, who tabulate the temperature and relative humidity every 3 hours throughout the test program. Each log covers 5 days. A sample form appears as Fig. 6. As with the Tower Logs, the engineer should discuss the logs and their maintenance with Weather Office personnel and make sure the procedure is thoroughly understood before proceeding to the next step.

INITIAL INSTALLATION

The DAI 607P portable noise level monitor used for NOISECHECK measurements is shown in Fig 7. Front-panel controls are labeled, and other components are identified.

The engineer working with this unit should be aware of 7 general warnings, applicable both during installation and during subsequent servicing of the units.

1. Do not leave boxes upside down or at angles greater than 45 degrees.

2. Do not switch power off until end of program.

3. Always keep at least one battery in place during program.

4. Always check to be sure that *all three* switches are set to right (i.e., "on," "A," and "slow").

5. When recalibrating, remove calibrator and make sure sound level (Read-0-Enter) is below threshold before reset (Print-0-Enter).

6. Always check time, battery voltage (6.4 V is max, 5.6 V is low limit), and paper supply before leaving box.

7. Always use desiccant packages (8 units) per instrument box. Check and replace as necessary with each servicing of the monitors.

DATE/TIME (L)	WIND DIR/SPEED (°TRUE/KTS)	TEMP (°F)	REL HUMIDITY	DATE/TIME (L)	WIND DIR/SPEED (°TRUE/KTS)	TEMP (°F)	REL HUMIDITY
/0100				/1300			
0400				1600			
0700				1900			
1000				2200			
1300				/0100			
1600				0400			
1900				0700			
2200				1000			
/0100				1300			
0400				1600			
0700				1900			
1000				2200			
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1600				0400			
1900				0700			
2200				1000			
/0100				1300			
0400				1600			
0700				1900			
1000				2200			

FIG. 6. WEATHER LOG FORM.

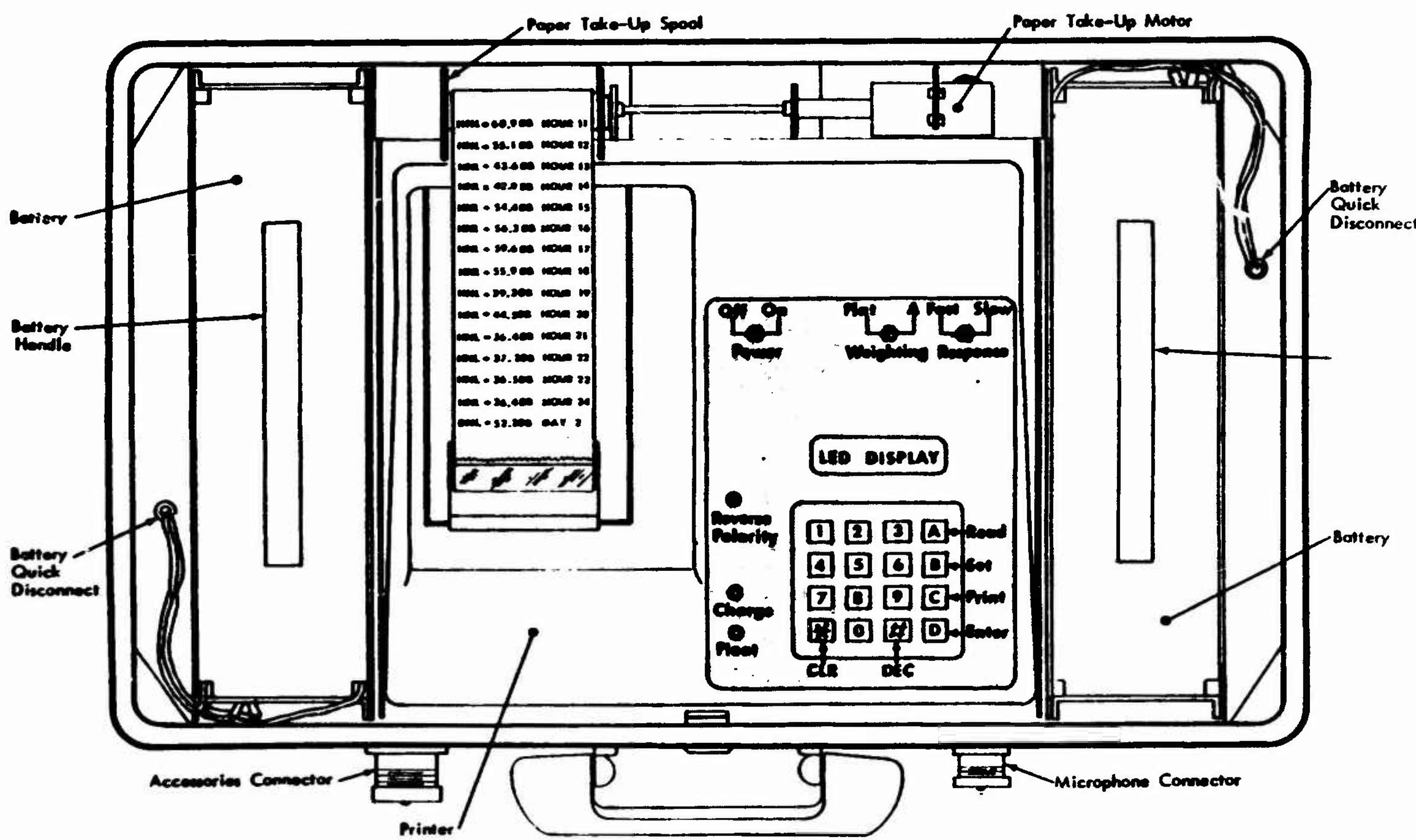

FIG. 7. PORTABLE NOISE LEVEL MONITOR.

Figure 8 shows the data heading listings of the portable noise monitor unit, all of which correspond to the initial setup commands given the unit.

In the field, initial installation of the unit involves 18 steps.

1. Erect tripod to its full height, install microphone holder vertically, place microphone in holder, connect microphone cable to monitor, place calibrator on microphone, switch on calibrator, switch on monitor, and wait 30 seconds.

2. Calibrate (Set-0-Enter).

3. Read level (Read-1-Enter). If the level indicated in the display is different from 114.0, recalibrate (steps 2 and 3).

4. Read the Cal Offse (Read-29-Enter). The value should be between 20 and 3. If the value is over 100, the microphone is not connected or the calibrator is not on. Check and repeat the calibration (steps 2 through 4). The unit is now calibrated.

5. Disconnect microphone cable and turn off the calibrator.

6. Set time 15 seconds before an integer minute (Set-2-Enter HH.MM). At the minute mark, press Enter.

7. Read the time in hours and minutes (Read-2-Enter) and in minutes and seconds (Read-40-Enter). If the time is incorrect, repeat steps 5, 6, and 7.

8. Set header information:

   - Day (Set-9-Enter-XX-Enter)
   - Location (Set-1-Enter-XX.XX-Enter)
   - SEL Threshold, if other than 60 dB (Set-5-Enter-XX.XX-Enter)
   - Print SEL (Print-1-Enter).

HEADER

```
SER= 102  LOC=  2.00
CAL= 20.6DB   DAY
THRESHOLDS:
         SEL= 60.0DB
   HNL/CNEL=  0.0DB
INTERVAL DURATION=
              1H  0M
CNEL/DNL BEG  0H  0M
INTERVAL BEG  0H  0M
BATTERY VOLTAGE= 6.0
PRINT MODES: 1234
START AT 16H 27M 83S
```

Portable Noise Level monitor unit serial number

Internal voltage. offset based on calibration

LEQ Interval duration, Operator entry, 1 hour otherwise.

LEQ Interval beginning, operator entry, 0 hour (midnight) otherwise.

Battery voltage
6.4 maximum
5.6 minimum.

Time print - zero command was entered and unit activated.

Location number operator entry, zero otherwise

Day number operator entry, zero otherwise increases automatically

SEL threshold operator entry, 60.0 dB otherwise

HNL threshold operator entry (=SEL THR) 0 dB otherwise

DNL beginning operator entry, 0 hour (midnight) otherwise

Functions printed
1-SEL 4-CNEL
2-HNL 5-LEQ
3-DNL
operator entry
234 otherwise

FIG. 8. DESCRIPTION OF PORTABLE NOISE LEVEL MONITOR DATA HEADER LISTINGS.

9. Print status and activate monitor (Print-0-Enter).

10. If status is in error, Set-24-Enter, recalibrate, and change the particular item (e.g., SEL threshold or time), and print status again (Print-0-Enter).

11. Verify all three switches set to right ("On," "A," "Slow").

12. Check battery voltage and paper supply to make sure the monitor will last during the planned unattended measurement period.

13. Select measurement site and security method. The microphone should have unobstructed "view" of the aircraft, and the monitor should be inconspicuous and near a post or tree.

14. Chain monitor to the post or tree with two padlocks, one for a chain loop around the stanchion and the second for a chain loop around the monitor. Keep the chain loop around the monitor under the handle and as tight as possible to discourage theft.

15. Position microphone.

16. Install windscreen.

17. Connect microphone cable input.

18. Cover monitor with plastic bag for rain protection, and secure microphone extension connector under cover if possible.

SERVICING UNITS

The engineer should visit the noise level monitor once a day for several reasons: collecting data records, checking on correct operation, recalibrating, and confirming the unit's security.*

---

*Measurement errors due to drift of the monitor gain can be minimized by recalibrating just after midnight. Calibration at that time reduces the drift gain bias of daily DNL reports.

A service visit to the unit involves 19 steps:

1. Disconnect microphone input.

2. Unlock box, leave lock on chain.

3. Open box, print status (Print-0-Enter). Annotate any unusual circumstances.

4. Inhibit (Set-24-Enter).

5. Place calibrator vertically on the microphone, reconnect microphone input, wait 30 seconds.

6. Recalibrate (Set-0-Enter).

7. Read level (Read-1-Enter). If other than 114.0, recalibrate again (Step 6).

8. Read CAL offset (Read-29-Enter). If more than 0.2 dB different from previous status (Step 3), recalibrate again (Steps 6, 7, and 8) until CAL offset repeats itself.

9. Remove calibrator, disconnect microphone input, wait 10 seconds check to see if sound level is below threshold (Read-1-Enter).

10. Check time (Read-2-Enter); if incorrect, enter new time (Set-2-Enter-HH.MM-Enter), then reset (Print-0-Enter).

11. Do paper work.

    - Pull about two inches of paper from printer and tear off.

    - Remove left battery. (Caution: Do not disconnect both batteries at the same time.)

    - Remove spool.

    - Remove paper from spool.

    - Reinstall spool.

    - Check paper supply. If less than required for next time period, replace with new roll.

- Lower printer lid. (Caution: Make sure paper release level is down and paper roller is in slots.)

- Reattach paper to spool.

- Replace left battery.

- Take up slack (Print-0-Enter).

12. Verify that battery voltage is adequate, 0.2 to 0.3 V needed per day, 5.6 V minimum.

13. If header is incorrect (for example, wrong location), make correction and reprint status (Print-0-Enter).

14. Check switches (all should be to the right).

15. Put calibrator in box, close the lid carefully without force.

16. Redo chain through handle, keep tight around box.

17. Reposition microphone pointing at aircraft; reinstall windscreen.

18. Recover box, reconnect microphone input, secure connector under cover if possible. (Caution: Do not leave box upside down or at angles greater than 45 degrees.)

19. Leave site quietly.

PHOTOGRAPHIC DOCUMENTATION

During NOISECHECK field measurement programs, two kinds of photographic documentation are needed:

- Identification of measurement sites

- Slant-distance photographs of aircraft.

Site Identification.

Each measurement site should be identified for future reference. Ideally, an identification picture should contain 3 elements:

- A microphone
- A recognizable landmark
- An aircraft in a position that is typical in relation to the microphone.

In Fig. 9, all three elements are present.

Slant-Distance Photographs of Aircraft.

Slant-distance pictures of aircraft at the point of closest approach to microphone positions should be taken for several purposes, including:

- To verify altitude profiles (useful in demonstrating typical aircraft operating during the measurement period)
- To determine the proportion of air-to-ground and ground-to-ground transmission (useful for backup in controversial situations)
- To compare an aircraft's measured SEL with NOISEFILE SEL values.

The following procedure should be used to determine the slant distance from photographs. It involves 5 tasks, each of which is discussed in detail below.

1. Select camera and lenses
2. Calibrate lenses
3. Take photograph of aircraft
4. Measure photographic images
5. Calculate slant distance.

Camera and Lens Selection: The most convenient camera to use for determining distance is a 35-mm single-lens reflex, with lenses of (approximately) 50-mm, 100-mm, and 200-mm focal lengths. Selection of the appropriate lens involves the anticipated distance to be measured and the size of the aircraft.

FIG. 9. TYPICAL SITE DOCUMENTATION PHOTOGRAPH SHOWING MICROPHONE, A RECOGNIZABLE LANDMARK, AND AN AIRCRAFT.

For example, the 50-mm lens should be used for distances less than 500 ft for all aircraft and is suitable up to about 1000 ft for larger aircraft (e.g., B-52, KC-135). For longer distances, the other lenses are recommended. Experimentation with the different lenses may be needed for a different situation. The goal is to achieve as large an image as possible without undue difficulty in framing the aircraft in the photo.

Lens Calibration: Each set of photographs (not necessarily each roll of film) should have a calibration picture for each lens, obtained by photographing an object of known size at a known distance. The object may be any convenient reference, such as two traffic cones or two vertical posts (small diameter) 10 ft apart, or a doorway of known dimensions, etc. The distance from the object to the camera and the size of the object should be measured within better than 1%. For the 50-mm lens, the distance could be 50 ft, for the 100-mm lens, 100 ft, etc.

Photographing the Aircraft: The aircraft should be held centered in the viewfinder with smooth movement of the camera. The photograph is taken at the point of *closest approach*. Some judgment is necessary to achieve this point. Typical cues vary from one aircraft to another and depend on the angle from which the photographs are taken. For aircraft flying overhead, it is possible to use the plane of the jet engine nacelles or the plane of the propeller for a reference. A nacelle inlet shows up as an ellipse from the front which gradually disappears as the aircraft is overhead, the point of closest approach. The photograph must be taken at this point. For propeller aircraft, the propeller plane becomes visible very briefly when it is in line with the viewer. If the aircraft is to the side, it is usually possible to observe two points on opposite sides of the aircraft, e.g., outboard engine nacelles or wingtips, as they appear to pass each other. This is the point to take the photograph.

Measurement of Photographic Images: When prints are used, care must be taken to ensure that all frames, including the calibration frames, are enlarged by exactly the same amount. When slides are used, one procedure is to project the slide on a flat, white screen (a sheet of paper is adequate) about 3 ft × 4 ft. The center of the screen should be on a level with the projector lens centerline and perpendicular to it. Once the projector is positioned for a given set of photographs, it should not be moved.

The size of the projected image of the calibration object is first measured. Each aircraft image is then measured along a selected dimension, which will depend on the aircraft type and orientation. The most convenient measure of aircraft length is usually the length of the fuselage. If the horizontal tail surfaces are mounted close to the fuselage, the measured distance may be from the nose to the back of the elevators for overhead views. This measurement is not suitable to T-tailed aircraft where the horizontal tail surface is some distance from the fuselage, with consequent potential for error. For wingspan measurements, it is usually most convenient to measure from tip to tip. For aircraft with tip tanks, the distance between the tip tank centerlines may be used. The dimension actually measured should be noted. For aircraft directly overhead, both the length and span dimensions should be taken.

Slant-Distance Calculation: The distance from the observer to the aircraft is given by the expression:

$$\text{Distance} = \text{Calibration Object Distance} \times \frac{\text{Calibration Image Size}}{\text{Calibration Object Size}} \times \frac{\text{Aircraft Dimension}}{\text{Aircraft Image Size}}.$$

It is most convenient to use the actual dimensions of the calibration object and aircraft in feet and the images in inches. Note that the dimensions generally listed for aircraft are the overall length and wingspan. If the dimensions measured were something different, e.g., fuselage length or tip tank centerlines, it is necessary to scale these dimensions from an accurate 3-view drawing.

DETERMINING THE ADEQUACY OF FIELD MEASUREMENTS

A field measurement program may be concluded when there are enough data. The first check for adequacy should be made when the number of data points (e.g., days for which DNL is available) is *one half* the number estimated as necessary when planning the program. Use the procedures described in Sec. 4 to check adequacy.

If the program is designed to measure DNL directly, recorded HNL, DNL, and the calibration offset values should be tabulated daily, at noon. The noise level monitor data record listings are described in Fig. 10.

NOISE LEVEL MEASUREMENTS

```
Sound Exposure Level, dB — SEL= 68.8DB                     {Day when SEL was
                           MAX= 81.1DB    DAY  7 —         {measured
Maximum A-weighted      }  DURATION=  22.75 SEC            {Total time
sound level during event}  MAX AT   10H 49M 56S            {A-weighted sound level
Time at which maximum   }                                  {exceeded SEL threshold
A-weighted sound level  }
occured.                }
Hourly Noise Level, dB — HNL= 74.2DB   HOUR 11 —           {Hour when HNL was measured,
                                                           {10-11 am
Hourly Noise Level, dB — HNL= 49.2DB   HOUR 24 —           {Hour when HNL was measured,
                                                           {11-12 pm

Equivelent Noise Level, dB — LEQ = 66.5DB   DAY  5 —       {Day when LEQ was
                             INTERVAL MAX= 66.6DB          {printed = measured
Maximum A-weighted }         OVER THR.24H   0M  0S         {day.
sound level        }         START AT  0H   0M             {Total time A-weighted
Time interval begun                                        {sound level exceeded
                                                           {SEL threshold

Day-Night Level, dB ——— DNL = 73.5DB   DAY  8 ——           {Day when DNL was
                                                           {printed = measured
                                                           {day.
```

FIG. 10. DESCRIPTION OF PORTABLE NOISE LEVEL MONITOR RECORD LISTINGS.

The engineer should also review the data in the field to identify any HNL values that were not dominated by aircraft operations (e.g., motorcycles, leaving calibrator on during measured hour, etc.). If the erroneous HNL biased the day's DNL, the HNL should be corrected and the DNL should be reconstructed using this corrected HNL.

If SELs are being measured, the recorded HNLs, the DNL, and the calibration offset value should also be tabulated daily at midnight.

4. DATA ANALYSIS

The data analysis procedures of this section allow an engineer to assess the probability that the values of DNL from NOISEMAP and the values of DNL from field measurements are consistent. When a low probability of consistency is evident, procedures are suggested that help assign the inconsistency to NOISEMAP or to inadequacy of measurements.

Analysis procedures are described for DNL synthesized from SELs. Figure 11 shows schematically the steps for each method. There may be several passes at this analysis before the measurement program is satisfactorily concluded. Preferably, the first pass should be done when one half of the estimated number of individual measurements (either SEL or DNL) have been made.

A series of worksheets allow the procedures to be accomplished in an orderly fashion. The discussion that follows is organized according to each worksheet and its steps. Worksheets 1 through 3 are used for SELs only, Worksheets 4 and 5 for both SELs and DNLs, and Worksheet 6 for DNLs only. All worksheets are included in Appendix B.

WORKSHEETS 1 TO 3: STEP-BY-STEP ANALYSIS OF SELs AND SYNTHESIS OF DNL FROM SEL

The most accurate method of estimating energy average busy-day DNL values employs measured SEL values. This method is required if the duration of the field measurement program is limited and high accuracy is desired. The analysis process consists of correlating portable noise level monitor SELs with individual operations from on-site logs or Tower Logs and analyzing the data in the 5 steps shown in Fig. 11a.

Worksheet 1 – Match Noise Levels With Aircraft and Operation

Individual operations should be identified by type of aircraft and operation at each site. If there were no direct observations at a site, which usually occurs, the Tower Log must be used to establish time correlations and identification of individual noise events. This is a time-consuming, but important, task.

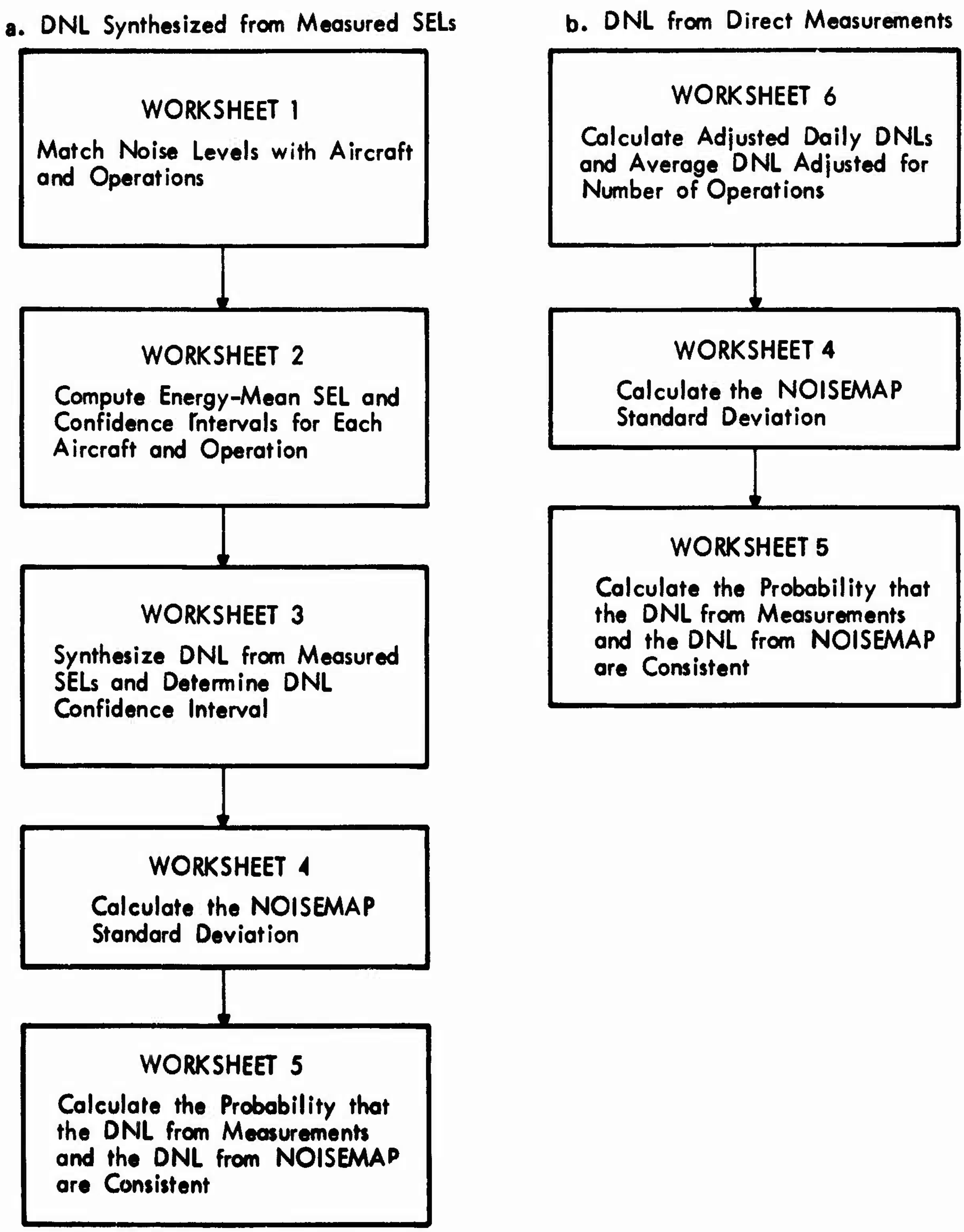

FIG. 11. SUMMARY OF DATA ANALYSIS PROCEDURE FOR COMPARISON OF DNL FROM MEASUREMENTS AND FROM NOISEMAP.

To reduce the time (and potential errors) of recopying data from sheet to sheet, copies of the Tower Log should be used as part of a Master Log. This Master Log consists of Worksheet 1, "Noise Level Log" (see Fig. 12), attached to the left-hand side of the Tower Log.

1. Fill in the headings for the site, engineer, and date on Worksheet 1.

2. Identify noise events by comparing Tower Log times and event descriptions with the event time on the portable noise level monitor paper tape output.

3. Enter SEL and maximum A-level values from the monitor tape output in the appropriate columns in Worksheet 1.

   a. Mark an asterisk beside all SEL values for which the maximum A-level is less than 9 dB above the noise monitor threshold value.

4. When all events have been identified and all SEL and maximum A-level data have been entered in the Master Log, go to Worksheet 2.

Worksheet 2 – Energy Average SEL and Confidence Intervals for Each Aircraft Operation

1. Fill in the headings for the site, engineer, and date on Worksheet 2 (see Fig. 13).

2. Determine the following for each aircraft and operation at each measurement site:

   - Number of measurements

   - Energy average SEL

   - Energy standard deviation

   - 90% confidence intervals for the energy average SEL.

Engineer ______________________

Measurement Date ______________________

Site ______		Site ______		Site ______		Site ______	
SEL	Max.	SEL	Max.	SEL	Max.	SEL	Max.

FIG. 12. NOISE LEVEL LOG (WORKSHEET 1).

Measurement Program____ Sheet___ of___

Site Number	________________
Engineer	________________
Measurement Date	________________

Runway	A/c	Oper.	No. of Meas., n_i	SEL_i	90% c.i. (+)	90% c.i. (-)	σ_i

FIG. 13. SEL COMPUTATION SHEET (WORKSHEET 2).

SUPPLEMENT TO WORKSHEET 2

1. Energy average noise level of aircraft and operation i:

$$\overline{SEL}_i = 10 \log \left[\frac{1}{n_i} \sum_{k=1}^{n_i} \text{antilog } (SEL_k/10) \right].$$

2. Energy standard deviation for aircraft and operation i:

$$\sigma_i = \sqrt{\frac{1}{n_i-1} \left\{ \sum_{k=1}^{n_i} \left[\text{antilog}(SEL_k/10) \right]^2 - \left[\sum_{k=1}^{n_i} \text{antilog}(SEL_k/10) \right]^2 / n_i \right\}}.$$

3. Confidence interval (c.i.) for aircraft and operation i:

$$\text{c.i.} = 10 \log \left[\text{antilog } (\overline{SEL}_i/10) \pm z_c \frac{\sigma_i}{\sqrt{n_i}} \right].$$

For a 90% confidence interval, $z_c = 1.645$; for a 95% confidence interval, $z_c = 1.960$.

a. Compute the above quantities using the 3 equations in the supplement to Worksheet 2, omitting all SEL values marked with asterisks. Enter the results of the computations on Worksheet 2.

b. Note that the 90% confidence intervals about the energy average SEL will be unsymmetrical when expressed in dB. The lower confidence interval will always be equal to or greater than the upper confidence interval. This is a logical result of calculations that involve the energy mean SEL.

c. Programmable calculators can be used to perform the calculations for Eqs. 1, 2, and 3 of the supplement to Worksheet 2. When the number of measurements per aircraft and operation is 50 or less, each SEL value can be entered individually in the calculator. When the number of measurements exceeds 50, it may save time (and lessen the possibility of error) to group the SEL data, per aircraft and operation, in 1-dB intervals, using the calculation sheet shown in Fig. 14. Calculator programs that handle grouped data can then be used to calculate the needed quantities.

3. Go to Worksheet 3.

Worksheet 3 — Synthesize the DNL for Measured SEL and Determine the DNL Confidence Interval

1. Fill in the headings for the site, engineer, and date on Worksheet 3 (see Fig. 15).

2. Enter the runway, aircraft, and operations for each type of operation that influences the site.

3. From Worksheet 2 (or from the SEL histogram calculation sheet shown in Fig. 14), enter the adjusted energy average SEL.

Measurement Program____ Sheet ____ of ____

Site Number ____________

Engineer ____________

Measurement Date ____________

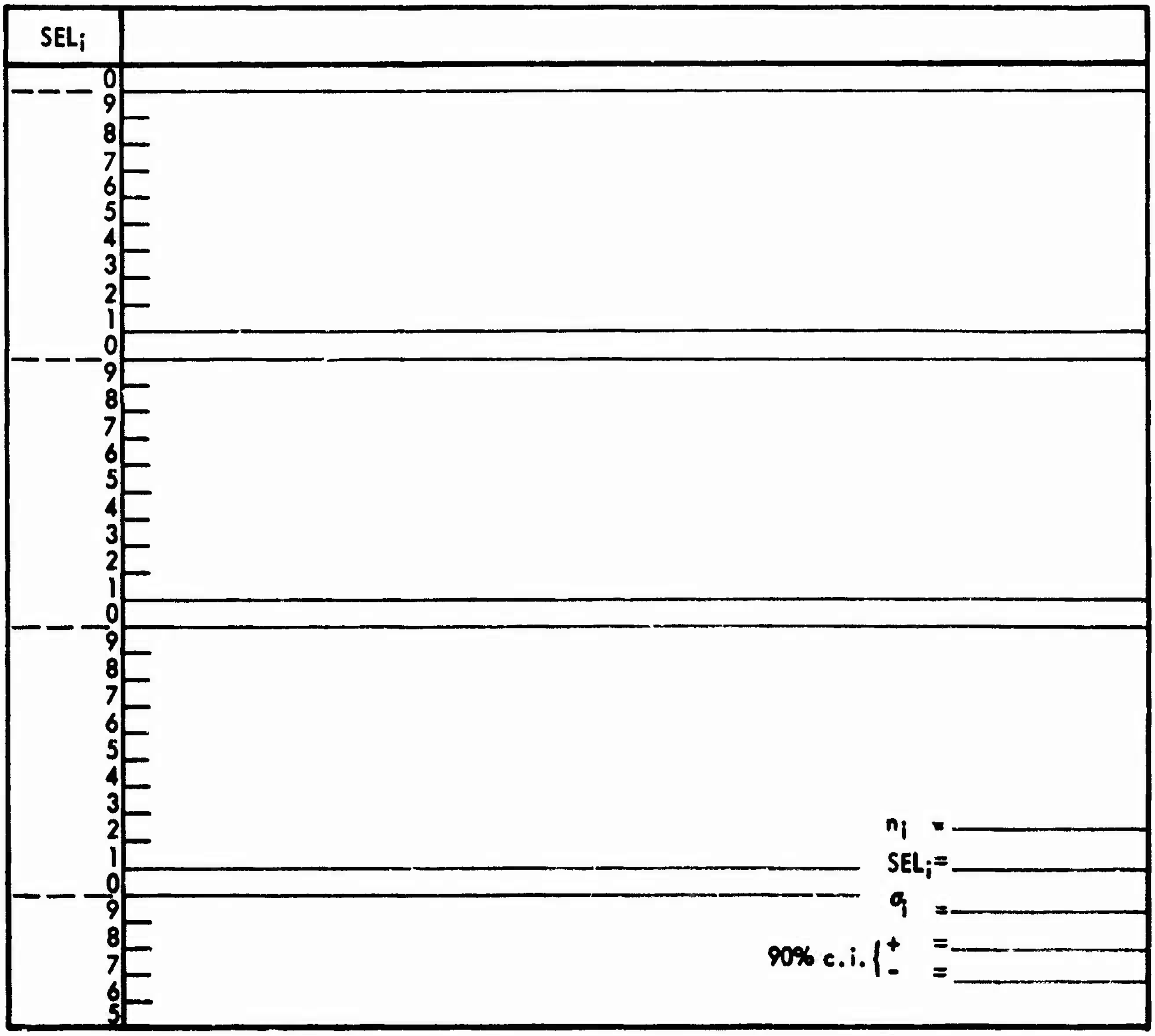

FIG. 14. SEL HISTOGRAM CALCULATION SHEET.

Measurement Program ____ Sheet ____ of ____

Site Number	
Engineer	
Measurement Date	

Runway	A/C	Oper.	Adj. SEL_i	N_i	n_i	σ_i

From Equations in Supplement

DNL		
σ		
90% c.i.	(+)	
	(-)	

FIG. 15. COMPUTED DNL AND CONFIDENCE INTERVAL FROM MEASURED SELs (WORKSHEET 3).

SUPPLEMENT TO WORKSHEET 3

1. DNL based on the adjusted energy average SELs:

$$\mathrm{DNL(S)} = 10 \log \left[\sum_{i=1}^{n_j} N_i \text{ antilog } (\overline{\mathrm{SEL}}_i/10) \right] - 49.4.$$

2. The standard deviation for antilog DNL(S)/10 is:

$$\sigma_s = \sqrt{\sum_{i=1}^{n_j} N_i{}^2 \sigma_i{}^2} \; .$$

3. The confidence intervals (c.i.) about the DNL are:

$$\text{c.i.} = 10 \log \left[\text{antilog}(\mathrm{DNL(S)}+49.4)/10 \pm z_c \sqrt{\sum_{i=1}^{n} N_i{}^2 \sigma_i{}^2/n} \right] - 49.4.$$

or

$$\text{c.i.} = 10 \log \left[\text{antilog}(\mathrm{DNL(S)}+49.4)/10 \pm z_c \sigma_s/\sqrt{n} \right] - 49.4.$$

For a 90% confidence interval, z_c = 1.645; for a 95% confidence interval, z_c = 1.960.

(Note: The confidence intervals, expressed in dB, will not be equal.)

a. The SEL is defined by integrating the noise signal over the upper 10 dB of the signal time history. Most field measurements compute the SEL by integration over a greater dynamic range, thus computing a slightly higher value than obtained by integration over only the upper 10 dB. The adjustment applied in this step to the measured SEL values compensates for this bias.

b. Compute the adjustment by (1) comparing the energy average SEL_i with the particular noise-monitoring unit A-level threshold, and (2) determining the adjustment from the following table.

SEL_i - Threshold Level (dB)	Adjustment (dB)
<18.0	0
18.1 - 22.0	-0.1
22.1 - 30.0	-0.2
>30.0	-0.3

4. From Worksheet 9 on page 81, enter the effective number of operations for each aircraft and operation during the "average busy day."

5. Using the 3 equations in the supplement to Worksheet 3, compute the DNL synthesized from SEL, which is denoted by DNL(S), the standard deviation, and the 90% confidence intervals for the computed DNL(S).

6. Go to Worksheet 4.

Worksheet 4 - Calculate the NOISEMAP Confidence Intervals and Standard Deviation

(Note: This worksheet is used for analyses that are based on DNL synthesized from measured SELs as well as on DNL measured directly.)

1. Fill in the headings for the site, engineer, and date on Worksheet 4 (see Fig. 16).

Measurement Program_____ Sheet ___of___

Site Number ________________
Engineer ________________
Date ________________

From Worksheet 9							From Chart Fig. 17	From Equation 3
Aircraft	Runway	Operation	Slant Distance	Elevation Angle	Aircraft SEL	Effective No. of Oper.	Variance	σ_i

NOISEMAP DNL	__________
Calculated σ	__________
90% c.i. (+)	__________
90% c.i. (-)	__________

FIG. 16. CALCULATE THE NOISEMAP CONFIDENCE INTERVALS AND STANDARD DEVIATION (WORKSHEET 4).

SUPPLEMENT TO WORKSHEET 4

1. The estimated standard deviation associated with each operation for which an SEL is listed on Worksheet 4 is:

$$\sigma_i = \sqrt{N_i \text{ antilog}(SEL_i/10)(VARIANCE_i)/18.86} \ .$$

2. The estimated standard deviation associated with antilog (DNL(C)/10) is:

$$\sigma_c = \frac{\sqrt{\sum_{i=1}^{\ell} \sigma_i^2}}{86,400} \ .$$

3. The estimated confidence intervals about the NOISEMAP computed DNL value are:

$$c.i. = 10 \log \left[\text{antilog}(DNL(C)/10) \pm z_c \sigma_c / \sqrt{\ell} \right] ,$$

where ℓ is the number of SELs listed on Worksheet 4.

For a 90% confidence interval $z_c = 1.645$; for a 95% confidence interval, $z_c = 1.960$.

2. From Worksheet 9 on page 81, enter the data for predominant operations that influence the noise at the site, including aircraft, runway, operation, slant distance, elevation angle, SEL at that slant distance/angle, and the effective number of operations.

3. Using Fig. 17, determine the variance for each kind of operation.

4. Using the equations in the supplement to Worksheet 4, calculate the estimated standard deviation and the 90% confidence intervals for the DNL computed from NOISEMAP, which is denoted by DNL(C).

5. Go to Worksheet 5.

<u>Worksheet 5 - Calculate the Probability that the DNL from Measurements and the DNL from NOISEMAP are Consistent</u>

1. Fill in the headings for the site, engineer, and date on Worksheet 5 (see Fig. 18).

2. From Worksheet 3 or 6, enter the DNL from measurements and the measurement standard deviation.

3. From Worksheet 4, enter the NOISEMAP standard deviation.

4. From NOISEMAP, enter the site Day-Night Level, DNL(C).

5. Using the equations in the supplement to Worksheet 5, calculate parameter z.

6. From Table 1, enter parameter p appropriate to the value of parameter z.

7. On Worksheet 5, calculate and enter the probability that the measurements and NOISEMAP are consistent.

8. Evaluate the resulting probability. The procedure for this evaluation is presented on page 65 directly after Worksheet 6.

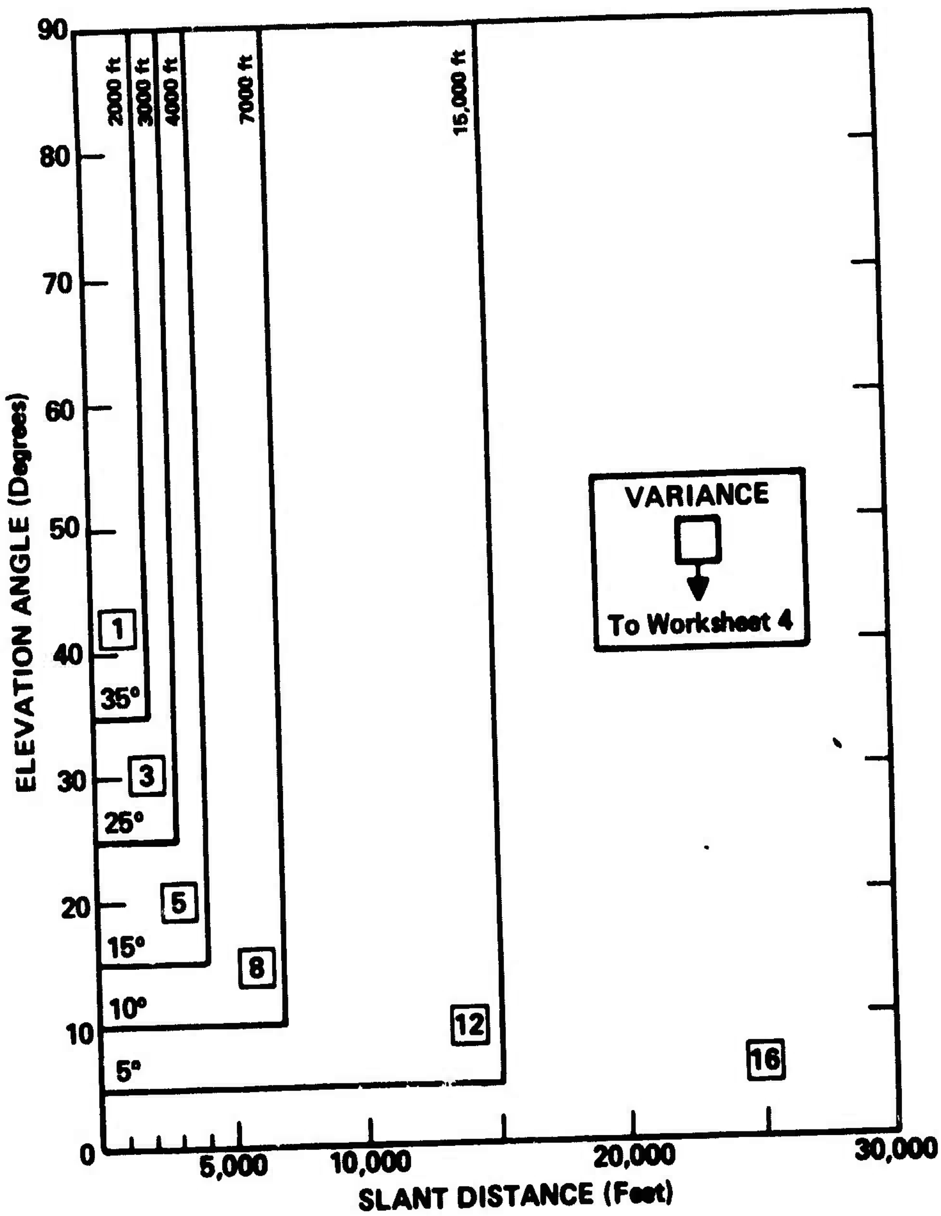

FIG. 17. ESTIMATE OF NOISEMAP VARIANCE.

Measurement Program ____ Sheet ___ of ___

File Number	
Engineer	
Date	

From Worksheet 3 or Worksheet 6		From Worksheet 4	From NOISEMAP
Measurement Standard Deviation	Measurement DNL	NOISEMAP Standard Deviation	NOISEMAP DNL
σ_S or σ_M	DNL(M) or DNL(S)	σ_i	DNL(C)

Calculated
Parameter Z

↓

From Table 1
Parameter p

↓

Calculated
Probability Equals 2 - 2p

This Value is the Probability that the Measurements and the NOISEMAP Predictions are Consistent.

(The Probability that they are not Consistent is 1 Minus this Value.)

FIG. 18. CALCULATE THE PROBABILITY THAT THE DNL FROM MEASUREMENTS AND THE DNL FROM NOISEMAP ARE CONSISTENT (WORKSHEET 5).

SUPPLEMENT TO WORKSHEET 5

For the measured DNL, denoted by DNL(M), that is computed from daily values of DNL (Worksheet 6), use:

1. $$z = \frac{|\text{antilog}(\text{DNL}(C)/10) - \text{antilog}(\text{DNL}(M)/10)|}{\sqrt{\sigma_C{}^2 + \sigma_M{}^2}} ,$$

or for synthesized DNL, denoted by DNL(S), that is computed from measured SELs (Worksheet 3), use:

2. $$z = \frac{|\text{antilog}(\text{DNL}(M)/10) - \text{antilog}(\text{DNL}(S)/10|}{\sqrt{\sigma_C{}^2 + \sigma_S{}^2}} .$$

TABLE 1. THE RELATIONSHIP OF PARAMETERS p AND z.

z_p	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

Step-by-Step Analysis of DNL from Direct Measurements (Worksheets 6, 4, and 5)

Measured DNLs for sites can be used directly. However, using daily measured DNL values directly will usually require a longer period of measurements to obtain the desired confidence levels. Also, since DNL contributions by different aircraft or operators are not identified, less information is available to determine possible reasons for any sizable differences between measured DNL and the DNL computed from NOISEMAP. Data analysis of directly measured DNL follows the three steps shown in Fig. 11b. (The final two steps are identical to the final steps of the analysis procedure used for analysis of values of DNL synthesized from SELs.)

Worksheet 6 — Calculate Adjusted Daily DNLs, Measurement Variance, and Measurement DNL

1. Fill in the headings for the site, engineer, and date on Worksheet 6 (Fig. 19).

2. Enter the date and day of the week for each measured DNL.

3. From the noise monitor paper tape, enter the day number and the DNL value.

4. Using Eq. 1 in the supplement to Worksheet 6 and hourly noise levels (HNLs) for hours without aircraft operations, calculate the background DNL and enter the value on Worksheet 6. (The background may be from other days as long as the levels are valid for the measurement day.)

   a. If hourly noise level data for hours without aircraft operations are not available, estimate the background DNL from other available noise data.

5. When the measured DNL exceeds the background noise DNL by less than 10 dB, use Eq. 2 of the supplement to obtain DNL' (the DNL adjusted for background noise). If the measured DNL exceeds the background DNL by 10 dB or more, an adjustment for background noise is not required.

Measurement Program____ Sheet __ of __

Site Number ________________

Engineer ________________

Date ________________

Date	Day of Week	From Paper Tape Day No.	From Paper Tape Meas. DNL	Bkgrnd. DNL (1)	DNL' (2)	Effective No. of Oper. (3)	No. Adj. (4)	Adj. DNL

(1) From Eq. 1 or Other Information

(2) From Eq. 2

(3) From Tower Log Analysis

(4) Adjustment $= -10 \log \dfrac{\text{Effective No. of Oper.}}{\text{NOISEMAP Effective No. of Oper.}}$

Calculated	
Measurement Std. Deviation	Measurement DNL

FIG. 19. CALCULATE DAILY DNL ADJUSTED FOR BACKGROUND AND NUMBER OF OPERATIONS (WORKSHEET 6).

SUPPLEMENT TO WORKSHEET 6

1. The background Day-Night-Level, DNL(BG), can be estimated from:

$$DNL(BG) = 10 \log \left\{ \left[(15 \text{ antilog } \overline{L}_{h_d}/10) + (90 \text{ antilog } \overline{L}_{h_n}/10) \right] /24 \right\},$$

where $\overline{L}_{h_d}$ is the energy average daytime hour without aircraft noise,

and $\overline{L}_{h_n}$ is the energy average nighttime hour without aircraft noise.

2. For each day

$$DNL' = 10 \log \left\{ \text{antilog } DNL/10 - \text{antilog } DNL(BG)/10 \right\}.$$

3. The energy average Day-Night Level, DNL(M) is:

$$DNL(M) = 10 \log \left[\left(\sum_{i=1}^{m} \text{antilog } DNL'/10 \right) /m \right],$$

where m is the number of adjusted daily DNLs on Worksheet 6.

4. The standard deviation for (antilog $\overline{DNL}$/10) is:

$$\sigma_M = \sqrt{\frac{1}{m_i - 1} \left\{ \sum_{i=1}^{m} \left[\text{antilog}(DNL_i'/10) \right]^2 - \left[\sum_{i=1}^{m} \text{antilog}(DNL_i'/10) \right]^2 /m \right\}}.$$

5. The confidence intervals about the $\overline{DNL}$ are:

$$c.i. = 10 \log \left[\text{antilog}(\overline{DNL} + 49.4) \pm z_c \frac{\sigma_M}{\sqrt{m}} \right].$$

For a 90% confidence interval, $z_c = 1.645$; for a 95% confidence interval, $z_c = 1.960$.

6. From analysis of the Tower Log, determine the effective number of aircraft operations per day, N_i. To determine the effective number of operations, consider only the operations of aircraft likely to influence the DNL at the site, taking into account the type of aircraft, mode of operation, and flight track. Use information from Worksheet 9 on page 81 to determine the type of aircraft, operations, and flight track that are relevant.

7. From Worksheet 9 and the supplement, determine the NOISEMAP effective number of operations N_r.

8. Determine the Number Adjustment for each daily DNL' value where:

$$\text{Number Adjustment} = -10 \log \frac{N_i}{N_r} .$$

Enter this adjustment value on Worksheet 6 for each daily DNL'.

9. Add the Number Adjustment to DNL' to obtain the adjusted DNL value. This adjustment represents the daily DNL value adjusted for differences between actual and NOISEMAP number of operations.

10. Calculate the measurement standard deviation and adjusted measurement DNL using Eqs. 3 through 5 in the supplement to Worksheet 6.

11. Go to Worksheets 4 and 5.

EVALUATING THE MEANING OF PROBABILITIES DERIVED FROM WORKSHEET 5

The probability derived from Worksheet 5 results from the combined statistics of the value of DNL from measurements and the value of DNL from NOISEMAP. The significance attached to a particular value of the probability will relate to the nature of the decision being made. Thus, if definition of the DNL 75 contour for property acquisition is the issue, probabilities that range from 90% to 95% might well be required.

The probability of consistency is related directly to three factors: (1) the difference between the two values of DNL (the offset), (2) the variance of the NOISEMAP DNL, and (3) the variance of the DNL from measurements.*

The probability of consistency *will* be high if the offset and the two variances are low; it *may* be high if the offset and the measured variance are low and the variance of NOISEMAP is medium or high.

If the probability of consistency obtained after analysis of the initial data is too low, the engineer must decide whether he can increase the probability and how to do it. He can use the three factors to diagnose the situation.

The first issue is whether the situation is clear or ambiguous. Table 2 represents three sets of situations in terms of their ambiguity and indicates ways to reduce the ambiguity.

The two cases in Set A clearly involve results that are not going to change. The values of DNL are very close, and in Case 1, error ranges are small; the probability of consistency is high. In Case 2, the variance of NOISEMAP controls the probability, but NOISEMAP and the measurements yield essentially the same answers.

In Set B, the measurement variance is low, and additional measurements will not help improve the probability of consistency. However, the offset is moderate to high. A high offset indicates that NOISEMAP is describing a different situation than was measured. If the input on operations and flight tracks are correct in NOISEMAP, the remaining area for difference is the SEL information in NOISEFILE. The NOISEFILE SELs and measured SELs should be compared and NOISEFILE properly adjusted. (To establish SEL data from NOISEFILE, use Worksheet 8 in Sec. 5.)

In Set C, the measurement variance is high. Additional measurements are required to eliminate that element of ambiguity. The case will become clear (Cases 1 or 2) or, if the offset remains high, more clearly focused on an issue of high to moderate offset (Cases 3 or 4).

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*Note that the real value of DNL at a site can be defined more precisely by increasing the number of measurements, even though the limitation in the accuracy of the NOISEMAP DNL may be fixed by the practical limitations of the NOISEMAP model. The best estimate of the DNL at a site is discussed in the next section.

TABLE 2. THE USE OF RESULTS FROM DATA ANALYSIS TO IMPROVE UNDERSTANDING OF THE RELATIONSHIP BETWEEN MEASUREMENTS DNLs AND NOISEMAP DNLs VARIANCE.

Case	Probability	Offset	Measured Variance	NOISEMAP Variance	Comments
A. Clear Cases — No Further Analysis Required					
1	High	Low	Low	Low	There is high consistency.
2	Moderate-high	Low	Low	Moderate-high	The lack of consistency is due to NOISEMAP and cannot be improved.
B. Ambiguous Cases — NOISEFILE SELs in doubt					
3	Low	High	Low	Low	Measurements will not help.
4	Moderate	Moderate	Low	Low to moderate	The inconsistency is due to basic noise values. Check NOISEFILE SELs against measured SELs.
C. Ambiguous Cases — More Measurements Required					
5	Moderate	Low	High	Low	Make more measurements. The results should become clear or the ambiguity reduced to that found in Cases 3 or 4.
6	Moderate-low	Moderate	High	Low	
7	Moderate	Low	High	High	
8	Low	High	High	High	

This analysis approach should be used for the data from each site. The analysis results are likely to vary from site to site. The basic characteristics of the variance of NOISEMAP give an indication of the nature of the problem to be addressed.

THE "BEST ESTIMATE" OF THE DNL AT A SITE

A remaining question concerns the real value of DNL at a site. The measurements and NOISEMAP present values of DNL. Each has an associated error range. The best estimate of the value of DNL can be computed after the engineer has achieved the highest possible probability of consistency by following the analysis procedures just discussed.

Taking the values of DNL from measurements and from NOISEMAP as well as their variances, compute the best estimate variance, the best estimate DNL, and the 90% confidence interval of the best estimate DNL using the following equations.

Note: Combining the measured DNL with the NOISEMAP DNL to obtain the best estimate should be done *only if* there is no reason to suspect any mistakes or errors in the measurements and NOISEMAP computations. For example, if field observations lead one to suspect that incorrect flight track information was used in the NOISEMAP computations, the NOISEMAP DNL should not be combined with the measurement DNL to obtain the best estimate.

a. For the measured DNL synthesized from SEL values, using information from Worksheets 2 and 3:

$$\overline{DNL} = 10 \log \left[\frac{n \text{ antilog}(DNL(S)/10) + \ell \text{ antilog}(DNL(M)/10)}{n + \ell}\right]$$

$$\sigma^2 = \frac{(n-1)\sigma_s^2 + (\ell-1)\sigma_c^2}{n + \ell - 2}$$

And the 90% confidence levels for $\overline{DNL}$ are:

$$\text{c.i.} = 10 \log \left[\text{antilog}(\overline{DNL}/10) \pm 1.645\sigma/\sqrt{n+\ell}\right]$$

b. For the measured DNL computed from daily DNL values, using information from Worksheets 3 and 4:

$$\overline{DNL} = 10 \log \left[\frac{m \text{ antilog}(DNL(M)/10) + \ell \text{ antilog}(DNL(M)/10)}{m + \ell} \right]$$

$$\sigma^2 = \frac{(m-1)\sigma_M{}^2 + (\ell-1)\sigma_c{}^2}{m + \ell - 2}$$

And the 90% confidence levels for $\overline{DNL}$ are:

$$\text{c.i.} = 10 \log \left[\text{antilog } (\overline{DNL}/10) \pm 1.645\sigma/\sqrt{m+\ell} \right].$$

5. DETERMINING MAJOR CONTRIBUTORS TO NOISEMAP DNL VALUES AT SPECIFIC SITES

NOISECHECK procedures rely on limited analysis of the aircraft noise information used by NOISEMAP to (1) predict the SEL at a point for comparison with measurements at that point and (2) determine the operations that contribute significantly to exposure at a point. This procedure requires accurate reconstruction of aircraft flight profiles from NOISEMAP chronicles to estimate NOISEFILE SEL values.

NOISEFILE SEL VALUES

Nominal SEL values for most military aircraft have been determined as a function of slant distance. The compilation of these data is called NOISEFILE. The data are available as computer tape files* and in Air Force Report AMRL TR-73-110, "Community Noise Exposure Resulting from Aircraft Operations: Acoustic Data on Military Aircraft" (1977). This report presents noise level vs distance data for takeoff power, cruise power, and approach power for each aircraft. Additional listings are presented for special power settings, such as afterburner and water injection. The report also presents an SEL adjustment for power settings and speeds that are not identical to the nominal values.

NOISEMAP AIRCRAFT OPERATIONAL PARAMETERS – GENERAL

Operational input information describing each individual aircraft mission is listed in the NOISEMAP chronicles and DATASCREEN summaries. The number of operations for each is summarized, but other parameters appear in the chronicles in the order in which the input data package was assembled. The parameters used to reconstruct NOISEMAP SEL values are:

- Flight tracks
- Altitude profile
- Delta SEL.

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*Contact the Air Force Aerospace Medical Research Laboratory, Biodynamic Environment Branch, Wright-Patterson Air Force Base, Ohio 45433.

DETERMINATION OF SELs AT A SITE

Two types of worksheets are used to determine SELs at a site. Worksheet 7 shown in Fig. 20a provides a summary of NOISEFILE data. Worksheet 8 shown in Fig. 21 consolidates the information for a particular aircraft and operation (e.g., KC-135A, pattern) and yields the SELs at sites of interest.

STEP-BY-STEP ESTIMATION OF NOISEFILE SEL VALUES

I. Use Worksheet 7, shown in Fig. 20a, to list SEL data from Air Force Report AMRL TR-73-110 that is pertinent to each aircraft and mission. (See filled-in example in Fig. 20b.)

   A. Enter operations type for the aircraft tabulated at top of table (e.g., operation/power settings: TAKEOFF in Fig. 20b).

   B. Enter aircraft type in first row of table. (There may be multiple entries because of different varieties of takeoff procedures, for example.)

   C. Enter the pertinent aircraft code (ACC) and operations code (OPC) in Row 2 (e.g., 026/102 in second column of Fig. 20b).

   D. Enter the corresponding power setting for the operations in percent, engine rpm, and/or exhaust pressure rating (EPR) in Row 3 (e.g., 96%/2.85 in second column of Fig. 20b).

   E. Enter the corresponding airspeed (knots) in Row 4 (e.g., 200).

   F. Enter the SEL (dB) tabulation as a function of the slant distance tabulated with the left-hand column. Note: Summaries of both air-to-ground and ground-to-ground are required.

II. Complete a Worksheet 8 to include altitudes, lateral distances, NOISEFILE SELs, Delta-SEL profiles, and numbers of operations for each aircraft in the NOISEMAP chronicle that could affect the measurement sites. See Fig. 20b for an example of a completed Takeoff form for a KC-135A pattern takeoff operation.

Measurement Program ________
Sheet____ of ________

Engineer____________________

Date ____________________

Air-To-Ground Propagation, Operation/Power Setting:

SlntDist.(ft)										
A/C Type										
ACC/OPC										
RPM/EPR										
Knots										
200										
250										
315										
400										
500										
630										
800										
1000										
1250										
1600										
2000										
2500										
3150										
4000										
5000										
6300										
8000										
10000										
12500										
16000										
20000										
25000										

Ground-To-Ground Propagation, Operation/Power Setting:

SlntDist.(ft)										
A/C Type										
ACC/OPC										
RPM/EPR										
Knots										
200										
250										
315										
400										
500										
630										
800										
1000										
1250										
1600										
2000										
2500										
3150										
4000										
5000										
6300										
8000										
10000										
12500										
16000										
20000										
25000										

FIG. 20a. NOISEFILE SEL SUMMARY (59°F, 70% R.H.) (WORKSHEET 7).

Measurement Program________
Sheet_____ of ________

Engineer________________

Date ________________

Air-To-Ground Propagation, Operation/Power Setting: Takeoff

SlntDist.(ft)	KC135A	KC135A	B52G	A-37	T-37	T-38	T-38	T-39	C-130A	
A/C Type	KC135A	KC135A	B52G	A-37	T-37	T-38	T-38	T-39	C-130A	
ACC/OPC	026/102	026/103	043/103	504/103	034/103	033/101	033/103	033/103	006/103	
RPM/EPR	96/3.95	96/3.45	94/3.37	100	99	100	100	100	1685/970	
Knots	200	200	170	300	170	300	300	180	170	
200	128.6	126.9	129.9	115.2	107.2	123.8	115.1	112.4	98.3	
250	127.1	125.6	128.6	113.9	105.0	122.0	113.9	111.1	97.2	
315	125.6	124.2	127.4	112.7	104.8	120.1	112.6	109.9	96.1	
400	124.2	122.8	126.1	111.3	103.6	118.3	111.3	108.6	94.9	
500	122.7	121.4	124.7	110.0	102.2	116.4	109.9	107.3	93.7	
630	121.2	120.0	123.3	108.5	100.9	114.6	108.5	105.9	92.4	
800	119.8	118.5	121.9	107.0	99.4	112.9	107.0	104.4	91.1	
1000	118.2	117.0	120.4	105.4	97.9	111.2	105.4	102.9	89.8	
1250	116.6	115.5	118.8	103.7	96.3	109.5	103.6	101.3	88.4	
1600	115.0	113.8	117.1	101.9	94.6	107.8	101.8	99.6	86.9	
2000	113.2	112.1	115.3	99.9	92.8	106.0	99.9	97.8	85.4	
2500	111.4	110.3	113.4	97.8	90.9	104.0	97.8	95.8	83.8	
3150	109.4	108.4	111.4	95.6	88.9	102.0	95.6	93.8	82.1	
4000	107.3	106.4	109.3	93.2	86.7	99.9	93.2	91.6	80.4	
5000	105.0	104.2	107.0	90.6	84.4	97.6	90.6	89.3	79.5	
6300	102.6	101.9	104.5	87.9	81.9	95.2	87.9	86.9	76.5	
8000	100.0	99.4	101.9	84.9	79.2	92.5	85.0	84.2	74.3	
10000	97.2	96.7	99.1	81.8	76.2	89.6	81.8	81.4	72.1	
12500	94.1	93.8	96.0	78.4	73.0	86.5	78.4	78.3	69.8	
16000	90.9	90.7	92.8	74.7	69.6	83.2	74.8	75.1	67.4	
20000	87.4	87.3	89.2	70.9	65.7	79.6	71.0	71.6	65.1	
25000	83.6	83.7	85.4	66.8	61.6	75.8	66.9	[illegible]	62.7	

Ground-To-Ground Propagation, Operation/Power Setting:

SlntDist.(ft)	KC135	KC135	B52G	A-37	T-37	T-38	T-38	T-39	C-130A	
A/C Type	KC135	KC135	B52G	A-37	T-37	T-38	T-38	T-39	C-130A	
ACC/OPC	026/[illegible]	026/103	043/103	504/103	034/103	033/101	033/103	033/103	006/103	
RPM/EPR	96/3.95	96/3.45	94/3.37	100	99	100	100	100	1685/970	
Knots	200	200	170	300	170	300	300	180	170	
200	123.6	121.9	124.9	110.2	102.2	118.8	110.1	107.4	93.3	
250	122.1	120.6	123.6	108.9	101.0	117.0	108.9	106.1	92.2	
315	120.6	119.2	122.4	107.7	99.8	115.1	107.6	104.9	91.1	
400	119.1	117.8	121.1	106.3	98.6	113.3	106.3	103.6	89.9	
500	117.7	116.4	119.7	105.0	97.2	111.4	104.9	102.2	88.7	
630	116.2	114.9	118.3	103.5	95.9	109.6	103.5	100.8	87.4	
800	114.6	113.5	116.8	102.0	94.4	107.9	102.0	99.4	86.1	
1000	113.1	111.9	115.3	100.4	92.9	106.2	100.3	97.8	84.7	
1250	111.3	110.3	113.7	98.7	91.2	104.4	98.6	96.2	83.2	
1600	109.5	108.5	112.0	95.8	89.5	102.6	96.7	94.4	81.6	
2000	107.6	106.7	110.1	94.8	87.6	100.7	94.8	92.6	79.9	
2500	105.3	104.5	108.1	92.7	85.5	98.6	92.6	90.4	77.9	
3150	102.6	102.1	105.8	90.3	83.2	96.2	90.2	88.0	75.6	
4000	99.4	99.2	103.1	87.6	80.4	93.5	87.6	85.3	73.0	
5000	95.7	95.8	100.0	84.5	77.2	90.2	84.4	82.1	70.0	
6300	91.5	92.0	96.5	81.0	73.6	86.6	81.0	78.5	66.7	
8000	87.4	88.7	93.3	77.6	70.3	83.3	77.5	75.2	63.7	
10000	83.7	85.0	89.7	73.7	66.6	79.6	73.7	71.4	69.4	
12500	79.1	80.8	85.7	69.5	62.5	75.4	69.5	67.3	56.8	
16000	73.9	76.2	81.3	64.7	57.9	70.7	64.7	62.7	52.7	
20000	68.3	71.1	76.4	59.4	52.7	65.4	59.4	57.5	49.5	
25000	62.3	65.4	70.8	53.4	46.9	59.5	53.5	51.9	44.2	

*Values listed do not reflect the NOISEFILE revision made in February 1980 for an improved model of sound duration as function of propagation distance.

FIG. 20b. EXAMPLE OF COMPLETED NOISEFILE SEL SUMMARY (59°F, 70% R.H.) (WORKSHEET 7).

Measurement Program________ Sheet __ of __

Site Number________________

Engineer________________

Oate________________

Aircraft Type________________

Operation________________

Mission________________

Altitude Profile Code________________

Power Profile Code________________

From Map				From Chronicle	
	Distances (feet)				
Site	Altitude	Lateral Distance	Downrange Distance	Noise Profile	Δ SEL

Use Eq. 1 in Supple- ment

	From Worksheet 7	NOISEFILE SEL + Δ SEL
Slant Distance	NOISEFILE SEL	Aircraft SEL

Use on Worksheet 9 or for AIRCRAFT SEL from NOISEFILE

FIG. 21. CALCULATION OF SLANT DISTANCE AND AIRCRAFT SEL AT SITES (WORKSHEET 8).

Supplement to Worksheet 8

1. Slant distance (ft) = $\sqrt{\text{perpendicular distance (ft)}^2 + \text{altitude (ft)}^2}$,

   where the lateral distance is the perpendicular distance from the measurement site to the point of closest approach on the flight track.

2. Angle β in degrees = $\sin^{-1}\left(\frac{\text{altitude}}{\text{slant distance}}\right)$.

A. Search chronicles for listings such as that shown below and, for each A/C type and operation, transfer the altitude profile (ALT PROF) and power profile (POW PROF) pertinent to each mission number. Transfer also the noise profile (NOISE PROF) appropriate to each site that is within the prescribed flight track limits.

Takeoff Descriptor Class No. – 261 A/C-KC-135A

Mission No. – 2

ALT PROF – 2612

POW PROF – 2612

TURN RAD – 6000.0 ft

SUBFLIGHT	NOISE PROF	TRACK LIMITS (FT)
1	262	0.0 to 27,000.0
2	263	27,000.0 to 1,000,000.0

B. From the Flight Operations Summary by Aircraft in the NOISEMAP chronicles, enter, for the aircraft selected, the total of day and night numbers of operations for the listed operation and mission number appropriate to the flight tracks near the measurement sites. For example, in the KC-135A summary from the NOISEMAP chronicle shown in Fig. 22, the measurement sites nearer to Runway 14 are identified by mission number, and only numbers of approach operations near the measurement sites must be extracted because of this site/runway configuration. However, for sites nearer Runway 32, the daytime number of straight-out takeoffs for mission No. 2 would be 0.120 + 0.901 + 0.720 + ... = 2.581. Cursory examination of the chronicles of individual ALT and POW profiles pertinent to missions 31 through 35 (for the KC-135A) shows that their profiles (see Fig. 22) are identical. Furthermore, description (by runway number) in the chronicles of the flight tracks for these missions indicates that all of these missions are pattern flights (see Fig. 22). Thus, the sum (8.602) of the individual daytime operations is entered for KC-135A approach pattern missions 31 through 35 over sites closer to Runway 14.

KC-135A AIRCRAFT

NAME	NO	MSN	FLIGHT TRACK CODE	NUMBER OF OPERATIONS 0701-2200	NUMBER OF OPERATIONS 2201-0700	AIRCRAFT OPERATIONS
K135A B3	0261	0023	14B3	3.810	1.320	16.2 %
K135A C1	0261	0031	14CF	.461	.135	3.1 %
K135A C2	0261	0032	14CG	1.720	.270	6.3 %
K135A C3	0261	0033	14CH	3.440	.540	12.6 %
K135A C4	0261	0034	14CI	1.720	.270	6.3 %
K135A C5	0261	0035	14CJ	.861	.135	3.1 %
KC-135A	0261	0010	14E	3.180	.510	5.8 %
KC-135A	0261	0002	104	.120	.020	.2 %
KC-135A	0261	0003	104	.030	.005	.1 %
KC-135A	0261	0002	83	.901	.140	1.6 %
KC-135A	0261	0003	83	.210	.030	.4 %
KC-135A	0261	0002	88	.720	.110	1.3 %
KC-135A	0261	0003	88	.159	.030	.3 %
KC-135A	0261	0002	93	.120	.020	.2 %
KC-135A	0261	0003	93	.030	.005	.1 %
KC-135A	0261	0002	98	.720	.110	1.3 %
KC-135A	0261	0003	98	.159	.030	.3 %
TOTAL RUNWAY 14			TAKEOFFS	15.581	3.170	
			LANDINGS	15.592	3.180	
			OPERATIONS	37.523		59.3

(A) KC-135A SUMMARY NUMBER OF OPERATIONS

```
***  ALTITUDE PROFILE            NAME =   26131
      TRACK DIST       ALTITUDE
     ------------    ------------
           0. FT           0. FT
        4500. FT           0. FT
        9500. FT         200. FT
       23500. FT        1700. FT
      208300. FT        1700. FT
      247300. FT           0. FT

***  DELTA-SEL   PROFILE         NAME =   26131   K135   C1
      TRACK DIST      REL POWER (DB)
     ------------    -------------
           0. FT          6.9
       10000. FT          6.9
       18000. FT         -7.4
       19000. FT         -3.4
      207000. FT         -3.4
      208000. FT         -2.5
```

(B) ALTITUDE AND DELTA-SEL PROFILES

```
***   TAKE-OFFS      FLIGHT TRACK   32CF
                     PROCEED      31000. FT
                     TURN RIGHT   90.0 DEG   WITH   6000. FT   RADIUS
                     PROCEED      13800. FT
                     TURN RIGHT   90.0 DEG   WITH   6000. FT   RADIUS
                     PROCEED      91000. FT
                     TURN RIGHT   90.0 DEG   WITH   6000. FT   RADIUS
                     PROCEED      13800. FT
                     TURN RIGHT   90.0 DEG   WITH   6000. FT   RADIUS
                     PROCEED      60000. FT

                        FLIGHT OPERATIONS   -   TRACK 32CF
                     A/C NO   MISSION       -     0701-2200  2201-0700

***   K135A C          026        31                .570       .090
```

(C) DESCRIPTIONS BY RUNWAY

FIG. 22. EXAMPLE FROM NOISEMAP CHRONICLE (KC-135A).

C. Prepare a map showing runways, measurement sites, and flight tracks for missions.

D. Indicate altitudes for each mission.

E. Draw lines through each site and perpendicular to the flight track.

F. Enter down-range distance from start of takeoff roll, altitude, and perpendicular distance in Worksheet 9.

G. Using Eq. 1 in the supplement to Worksheet 8, calculate the slant distance from the perpendicular distances and the altitudes and enter in Worksheet 8.

Note: An altitude profile code of "ϕ" indicates that the profile is that of the glide slope for that runway and assumes that the aircraft is 50 ft above the runway at its threshold. The glide slope is listed in the chronicles within the runway description immediately following the runway number heading, as shown below.

```
                           ---------------------------
***                            R U N W A Y    14
                           ---------------------------
LENGTH 11829.4 FT, GL. SLOPE  2.50 DEG. HEADING 144.6 DEG
START (1639610.0,  674620.0), END (1644320.0,  664260.0)
DISPLACEMENTS - TAKEOFF       0.0, LANDING       0.0
****************************************************************
```

H. Consolidate onto one sheet (for a given aircraft type) any grouping of ALT and POW profile numbers which, while different in number, are identical in actual profile.

I. From the NOISEMAP chronicle, enter the Delta-SEL profile data corresponding to the appropriate down-range distance.

J. Enter the Noise Profile pertinent to each site by referring to the track limits and corresponding noise profile in the chronicles.

K. Using Eq. 2 in the supplement to Worksheet 8, calculate the angle above the horizon, β. If angle β from any site is less than 7°, enter this in parentheses beside the Noise Profile Code for that site.

L. Calculate the NOISEFILE SEL and A/C SEL for each site, given the Noise Profile Delta-SEL on the sheet and the ACC/OPC Codes from Fig. 20.

1. For 3-digit Noise Profile Codes, the 2 left-most digits of the Noise Profile Code are the 2 right-most digits of the ACC Code. The right-most digit of the Noise Profile Code is the right-most digit of the OPS Code. Enter the NOISEFILE SEL Summary (Worksheet 7), and select the appropriate column (from the ACC/OPC Code shown).

2. For Noise Profile Codes with more than 3 digits, the corresponding ACC and OPC Codes are similarly extracted; for nonobvious contractions or relationships, refer to the code numbers in Appendix B of Air Force Report AMRL TR-73-110. From the code numbers shown therein and their corresponding air speeds (knots) and Power Conditions (rpm/EPR), cross-check to the appropriate column already generated in the NOISEFILE SEL Summary, Worksheet 7.

3. Given the slant distance appropriate to each aircraft and site, find the NOISEFILE SEL from the appropriate column(s) by the formula:

$$SEL = SEL_{G-G} \quad \text{for } \beta \leq 4^{\circ}$$

$$SEL = SEL_{G-G} + \frac{\left(SEL_{A-G} - SEL_{G-G}\right) \times (\beta - 4)}{3} \quad \text{for } 4^{\circ} \leq \beta \leq 7^{\circ}$$

$$SEL = SEL_{A-G} \quad \text{for } \beta \geq 7^{\circ}$$

i. For interpolation at distance D_X between shorter distance D_1 listed and greater distance D_2 listed, use the formula:

$$SEL_X = SEL_1 - \left(SEL_1 - SEL_2\right) \frac{\text{Log}(D_X/D_1)}{\text{Log}(D_2/D_1)} \ .$$

ii. Tabulate on Worksheet 9 the NOISEFILE SEL values thus determined for each site, add the corresponding Delta-SEL corrections to yield the A/C SEL, and enter these also on Worksheet 8.

This concludes the procedure for estimating the SEL at a point from analysis of NOISEMAP and NOISEFILE data. This "NOISEFILE SEL" may be used three times during NOISECHECK: (1) to estimate the "partial DNL" from individual types of operations at a site so that the relative importance of various operations can be assessed during the planning phase (Worksheet 9) (see Fig. 23); (2) to estimate the variance of NOISEMAP during data analysis (Worksheet 4); and (3) to seek out reasons why values of DNL from measurements differ from NOISEMAP values of DNL.

Step-by-Step Procedure to Determine the Significant Contributors to DNL at a Site

1. Complete headings for program, site, engineer, and date.

2. From Worksheet 8, transfer the following data for this site: aircraft, operation, mission number, aircraft SEL, and numbers of operations.

3. Using Eq. 1 in the supplement to Worksheet 9, calculate the effective number of operations for each operation and enter on Worksheet 9.

4. Using Eq. 2, calculate the partial DNL for each operation.

5. Rank order operations in terms of decreasing DNL.

6. Using Eq. 3, list "total DNL through rank" for each operation (i.e., for the operation ranked 2, this is $DNL_1 + DNL_2$, and for the operation ranked 3, this is $DNL_1 + DNL_2 + DNL_3$, etc.) until the total is within 0.3 dB of the NOISEMAP DNL for this site.

Measurement Program________ Sheet __ of __

Site Number________________

Engineer________________

Date________________

From Worksheet 8					
Aircraft	Operation	Mission	Aircraft SEL	Day Operations	Night Operations

Use Equations in Supplement

Calculated			
Effective Numbers of Operations	Partial DNL	Rank Number	Total DNL Through Rank

FIG. 23. STEP-BY-STEP ESTIMATION OF THE RELATIVE IMPORTANCE OF OPERATIONS AT A SITE (WORKSHEET 9).

Supplement to Worksheet 9

1. $$\text{Effective number of operations} = \left(\begin{array}{c}\text{number of day}\\ \text{operations}\\ \text{(0700-2200)}\end{array}\right) + 10\left(\begin{array}{c}\text{number of night}\\ \text{operations}\\ \text{(2200-0700)}\end{array}\right).$$

2. $$\text{Partial DNL} - \text{Aircraft SEL} + 10 \log \left(\begin{array}{c}\text{Effective}\\ \text{number of}\\ \text{operations}\end{array}\right) - 49.4.$$

3. $$\text{Total DNL through rank} = 10 \log \left[\left(10^{DNL_1/10}\right) + \cdots + \left(10^{DNL_n/10}\right)\right],$$

where n is the rank number being calculated.

7. All operations contributing to this total should be considered significant contributors to the site DNL. SEL data should be obtained for these operations during NOISECHECK.

APPENDIX A: LOG SHEETS

AIRCRAFT TOWER LOG

Installation ____________

Date ____________

Runway(s) ____________

TIME	AIRCRAFT							OPERATIONS				
							Other	Runway	T/O*	Approach†	T & G	Other

*Takeoff

SO - Straight Out

P - Pattern

R - Right Turn Departure

L - Left Turn Departure

† Approach

SI - Straight In

P - Pattern

Measurement Program___________

Sheet ___ of ___

Installation___________

Date ___________

Runup Pad or Test Cell___________

AIRCRAFT MAINTENANCE LOG

Aircraft Type	Aircraft Orientation on Runup Pad	Power Setting	Time		Total Time at Setting	Comments
			Start to Setting	End at Setting		

WEATHER LOG

DATE/TIME (L)	WIND DIR/SPEED (°TRUE/KTS)	TEMP (°F)	REL HUMIDITY	DATE/TIME (L)	WIND DIR/SPEED (°TRUE/KTS)	TEMP (°F)	REL HUMIDITY
/0100				/1300CDT			
0400				1600			
0700				1900			
1000				2200			
1300				/0100			
1600				0400			
1900				0700			
2200				1000			
/0100				1300			
0400				1600			
0700				1900			
1000				2200			
1300				/0100			
1600				0400			
1900				0700			
2200				1000			
/0100				1300			
0400				1600			
0700				1900			
1000				2200			

APPENDIX B: CHECKLISTS

AIRCRAFT TOWER LOG PROCEDURE

1. Log every aircraft movement that affects the measurement area.
2. Use check marks for aircraft types listed. Identify others.
3. Describe the aircraft operation with the code letters listed at the bottom of the form. Note that for touch-and-go or flyby operations, entries are required for both approach and takeoff. Include under "comments" the flight track identifications.
4. List the time at which the aircraft passes the tower.
5. Begin a new sheet at start of new duty day (midnight).
6. Note any runway changes at the time of change.
7. Indicate under "comments" if the practice pattern was radar controlled (R) or visually controlled (VFR).

AIRCRAFT MAINTENANCE AND RUNUP LOG PROCEDURE

1. Log every maintenance runup.

2. Use a separate sheet each day for each runup pad or test cell.

3. List the power setting for each test segment as well as the start time and end time at that setting (hours, minutes, seconds).

4. Indicate under "comments" any unusual occurrence during a runup.

INITIAL INSTALLATION OF PORTABLE NOISE MONITOR

In the field, initial installation of the unit involves 18 steps.

1. Erect tripod to its full height, install microphone holder vertically, place microphone in holder, connect microphone cable to monitor, place calibrator on microphone, switch on calibrator, switch on monitor, and wait 30 seconds.

2. Calibrate (Set-0-Enter).

3. Read level (Read-1-Enter). If the level indicated in the display is different from 114.0, recalibrate (Steps 2 and 3).

4. Read the Cal Offset (Read-29-Enter). The value should be between 20 and 23. If the value is over 100, the microphone is not connected or the calibrator is not on. Check and repeat the calibration (Steps 2 through 4). The unit is now calibrated.

5. Disconnect microphone cable and turn off the calibrator.

6. Set time 15 seconds before an integer minute (Set-2-Enter HH.MM). At the minute mark, press Enter.

7. Read the time in hours and minutes (Read-2-Enter) and in minutes and seconds (Read-40-Enter). If the time is incorrect, repeat Steps 5, 6, and 7.

8. Set header information:

   - Day (Set-9-Enter-XX-Enter)

   - Location (Set-1-Enter-XX.XX-Enter)

   - SEL Threshold, if other than 60 dB (Set-5-Enter-XX.XX-Enter)

   - Print SEL (Print-1-Enter).

9. Print status and activate monitor (Print-0-Enter).

10. If status is in error, Set-24-Enter, recalibrate, and change the particular item (e.g., SEL threshold or time), and print status again (Print-0-Enter).

11. Verify all three switches set to right ("On," "A," "Slow").

12. Check battery voltage and paper supply to make sure the monitor will last during the planned unattended measurement period. Put desiccant packages in.

13. Select measurement site and security method. The microphone should have unobstructed "view" of the aircraft, and the monitor should be inconspicuous and near a post or tree.

14. Chain monitor to the post or tree with two padlocks, one for a chain loop around the stanchion and the second for a chain loop around the monitor. Keep the chain loop around the monitor under the handle and as tight as possible to discourage theft.

15. Position microphone.

16. Install windscreen.

17. Connect microphone cable input.

18. Cover monitor with plastic bag for rain protection, and secure microphone extension connector under cover if possible.

Servicing Units

The engineer should visit the noise level monitor once a day for several reasons: collecting data records, checking on correct operation, recalibrating, and confirming the unit's security.*

---

*Measurement errors due to drift of the monitor gain can be minimized by recalibrating just after midnight. Calibration at that time reduces the drift gain bias of daily DNL reports.

CHECKLIST FOR SERVICE VISIT TO PORTABLE NOISE MONITOR

A service visit to the unit involves 20 steps:

1. Disconnect microphone input.

2. Unlock box, leave lock on chain.

3. Open box, print status (Print-0-Enter). Annotate any unusual circumstances.

4. Inhibit (Set-24-Enter).

5. Place calibrator vertically on the microphone, reconnect microphone input, wait 30 seconds.

6. Recalibrate (Set-0-Enter).

7. Read level (Read-1-Enter). If other than 114.0, recalibrate again (Step 6).

8. Read CAL offset (Read-29-Enter). If more than 0.2 dB different from previous status (Step 3), recalibrate again (Steps 6, 7, and 8) until CAL offset repeats itself.

9. Remove calibrator, disconnect microphone input, wait 10 seconds, check to see if sound level is below threshold (Read-1-Enter).

10. Check time (Read-2-Enter); if incorrect, enter new time (Set-2-Enter-HH.MM-Enter), then reset (Print-0-Enter).

11. Do paper work.

    - Pull about two inches of paper from printer and tear off.

    - Remove left battery. (Caution: Do not disconnect both batteries at the same time.)

    - Remove spool.

- Remove paper from spool.
- Reinstall spool.
- Check paper supply. If less than required for next time period, replace with new roll.
- Lower printer lid. (Caution: Make sure paper release level is down and paper roller is in slots.
- Reattach paper to spool.
- Replace left battery.
- Take up slack (Print-0-Enter).

12. Verify that battery voltage is adequate, 0.2 to 0.3 V needed per day, 5.6 V minimum.
13. If header is incorrect (for example, wrong location), make correction and reprint status (Print-0-Enter).
14. Check switches (all should be to the right).
15. Check and replace as necessary the desiccant packages.
16. Put calibrator in box, close the lid carefully without force.
17. Redo chain through handle, keep tight around box.
18. Reposition microphone pointing at aircraft; reinstall windscreen.
19. Recover box, reconnect microphone input, secure connector under cover if possible. (Caution: Do not leave box upside down or at angles greater than 45 degrees).
20. Leave site quietly.

APPENDIX C: WORKSHEETS

WORKSHEET 1
NOISE LEVEL LOG

Engineer ____________________

Measurement Date ____________________

Site ________		Site ________		Site ________		Site ________	
SEL	Max.	SEL	Max.	SEL	Max.	SEL	Max.

WORKSHEET 2
SEL COMPUTATION SHEET

Measurement Program____ Sheet___ of ___

Site Number ____________________

Engineer ____________________

Measurement Date ____________________

Runway	A/c	Oper.	No. of Meas., n_i	SEL_i	90% c.i. (+)	90% c.i. (-)	σ_i

SUPPLEMENT TO WORKSHEET 2

1. Energy average noise level of aircraft and operation i:

$$\overline{SEL}_i = 10 \log \left[\frac{1}{n_i} \sum_{k=1}^{n_i} \text{antilog } (SEL_k/10) \right].$$

2. Energy standard deviation for aircraft and operation i:

$$\sigma_i = \sqrt{\frac{1}{n_i - 1} \left\{ \sum_{k=1}^{n_i} \left[\text{antilog}(SEL_k/10) \right]^2 - \left[\sum_{k=1}^{n_i} \text{antilog}(SEL_k/10) \right]^2 / n_i \right\}} .$$

3. Confidence interval (c.i.) for aircraft and operation i:

$$\text{c.i.} = 10 \log \left[\text{antilog } (\overline{SEL}_i/10) \pm z_c \frac{\sigma_i}{\sqrt{n_i}} \right] .$$

For a 90% confidence interval, $z_c = 1.645$; for a 95% confidence interval, $z_c = 1.960$.

SEL HISTOGRAM CALCULATION SHEET

Measurement Program____ Sheet ____ of ____

Site Number __________

Engineer __________

Measurement Date __________

SEL_i	
0	
9	
8	
7	
6	
5	
4	
3	
2	
1	
0	
9	
8	
7	
6	
5	
4	
3	
2	
1	
0	
9	
8	
7	
6	
5	
4	
3	
2	n_i = ______
1	SEL_i = ______
0	
9	σ_i = ______
8	90% c.i. { + = ______
7	− = ______
6	
5	

WORKSHEET 3
COMPUTED DNL AND CONFIDENCE INTERVAL FROM MEASURED SELs

Measurement Program ____ Sheet ____ of ____

Site Number ____________

Engineer ____________

Measurement Date ____________

Runway	A/C	Oper.	Adj. SEL_i	N_i	n_i	σ_i

From Equations in Supplement

DNL ____________

σ ____________

90% c.i. { (+) ____________
(-) ____________

SUPPLEMENT TO WORKSHEET 3

1. DNL based on the adjusted energy average SELs:

$$DNL(S) = 10 \log \left[\sum_{i=1}^{n_j} N_i \text{ antilog } (\overline{SEL}_i/10) \right] - 49.4.$$

2. The standard deviation for antilog DNL(S)/10 is:

$$\sigma_s = \sqrt{\sum_{i=1}^{n_j} N_i^2 \sigma_i^2} \ .$$

3. The confidence intervals (c.i.) about the DNL are:

$$c.i. = 10 \log \left[\text{antilog}(DNL(S)+49.4)/10 \pm z_c \sqrt{\sum_{i=1}^{n} N_i^2 \sigma_i^2/n} \right] - 49.4,$$

or

$$c.i. = 10 \log \left[\text{antilog}(DNL(S)+49.4)/10 \pm z_c \sigma_s/\sqrt{n} \right] - 49.4.$$

For a 90% confidence interval, $z_c = 1.645$; for a 95% confidence interval, $z_c = 1.960$.

(Note: The confidence intervals, expressed in dB, will not be equal.)

WORKSHEET 4

CALCULATION OF THE NOISEMAP CONFIDENCE INTERVALS AND STANDARD DEVIATION

Measurement Program____ Sheet ___of__.

Site Number ________________

Engineer ________________

Date ________________

From Worksheet 9							From Chart Fig. 17	From Equation 3
Aircraft	Runway	Operation	Slant Distance	Elevation Angle	Aircraft SEL	Effective No. of Oper.	Variance	σ_i

NOISEMAP DNL ________

Calculated σ ________

90% c.i. $\left\{ \begin{array}{l} (+) \\ (-) \end{array} \right.$ ________ ________

SUPPLEMENT TO WORKSHEET 4

1. The estimated standard deviation associated with each operation for which an SEL is listed on Worksheet 4 is:

$$\sigma_i = \sqrt{N_i \text{ antilog}(SEL_i/10)(VARIANCE_i)/18.86}$$

2. The estimated standard deviation associated with antilog (DNL(C)/10) is:

$$\sigma_c = \frac{\sqrt{\sum_{i=1}^{\ell} \sigma_i^2}}{86,400}$$

3. The estimated confidence intervals about the NOISEMAP computed DNL value are:

$$c.i. = 10 \log \left[\text{antilog}(DNL(C)/10) \pm z_c \sigma_c / \sqrt{\ell}\right] ,$$

where ℓ is the number of SELs listed on Worksheet 4.

For a 90% confidence interval $z_c = 1.645$; for a 95% confidence interval, $z_c = 1.960$.

WORKSHEET 5

CALCULATE THE PROBABILITY THAT THE DNL FROM MEASUREMENTS AND THE DNL FROM NOISEMAP ARE CONSISTENT

Measurement Program____ Sheet___ of___

File Number	______________
Engineer	______________
Date	______________

From Worksheet 3 or Worksheet 6		From Worksheet 4	From NOISEMAP
Measurement Standard Deviation	Measurement DNL	NOISEMAP Standard Deviation	NOISEMAP DNL
σ_S or σ_M	DNL(M) or DNL(S)	σ_i	DNL(C)

Calculated
Parameter Z

From Table 1
Parameter p

Calculated
Probability Equals 2 - 2p

This Value is the Probability that the Measurements and the NOISEMAP Predictions are Consistent.

(The Probability that they are not Consistent is 1 Minus this Value.)

SUPPLEMENT TO WORKSHEET 5

For the measured DNL, denoted by DNL(M), that is computed from daily values of DNL (Worksheet 6), use:

$$1. \quad z = \frac{|\text{antilog}(DNL(C)/10) - \text{antilog}(DNL(M)/10)|}{\sqrt{\sigma_C^2 + \sigma_M^2}},$$

or for synthesized DNL, denoted by DNL(S), that is computed from measured SELs (Worksheet 3), use:

$$2. \quad z = \frac{|\text{antilog}(DNL(M)/10) - \text{antilog}(DNL(S)/10|}{\sqrt{\sigma_C^2 + \sigma_S^2}}.$$

Measurement Program_____ Sheet ___ of ___

Site Number	
Engineer	
Date	

WORKSHEET 6

CALCULATE DAILY DNL ADJUSTED FOR BACKGROUND AND NUMBER OF OPERATIONS

Date	Day of Week	From Paper Tape		Bkgrnd. DNL (1)	DNL' (2)	Effective No. of Oper. (3)	No. Adj. (4)	Adj. DNL
		Day No.	Meas. DNL					

(1) From Eq. 1 or Other Information

(2) From Eq. 2

(3) From Tower Log Analysis

(4) Adjustment $= -10 \log \dfrac{\text{Effective No. of Oper.}}{\text{NOISEMAP Effective No. of Oper.}}$

Calculated	
Measurement Std. Deviation	Measurement DNL

SUPPLEMENT TO WORKSHEET 6

1. The background Day-Night-Level, DNL(BG), can be estimated from:

$$DNL(BG) = 10 \log \left\{ \left[(15 \text{ antilog } \bar{L}_{h_d}/10) + (90 \text{ antilog } \bar{L}_{h_n}/10) \right] /24 \right\},$$

where $\bar{L}_{h_d}$ is the energy average daytime hour without aircraft noise,

and $\bar{L}_{h_n}$ is the energy average nighttime hour without aircraft noise.

2. For each day

$$DNL' = 10 \log \left\{ \text{antilog } DNL/10 - \text{antilog } DNL(BG)/10 \right\}.$$

3. The energy average Day-Night Level, DNL(M) is:

$$DNL(M) = 10 \log \left[\left(\sum_{i=1}^{m} \text{antilog } DNL'/10 \right) /m \right],$$

where m is the number of adjusted daily DNLs on Worksheet 6.

4. The standard deviation for (antilog $\overline{DNL}$/10) is:

$$\sigma_M = \sqrt{\frac{1}{m_i - 1} \left\{ \sum_{i=1}^{m} \left[\text{antilog}(DNL_i'/10) \right]^2 - \left[\sum_{i=1}^{m} \text{antilog}(DNL_i'/10) \right]^2 /m \right\}}.$$

5. The confidence intervals about the $\overline{DNL}$ are:

$$c.i. = 10 \log \left[\text{antilog}(\overline{DNL} + 49.4) \pm z_c \frac{\sigma_M}{\sqrt{m}} \right].$$

For a 90% confidence interval, $z_c = 1.645$; for a 95% confidence interval, $z_c = 1.960$.

WORKSHEET 7
NOISEFILE SEL SUMMARY

Measurement Program ________
Sheet____ of ________
Engineer____________________
Date ______________________

Air-To-Ground Propagation, Operation/Power Setting:

SlntDist(ft)										
A/C Type										
ACC/OPC										
RPM/EPR										
Knots										
200										
250										
315										
400										
500										
630										
800										
1000										
1250										
1600										
2000										
2500										
3150										
4000										
5000										
6300										
8000										
10000										
12500										
16000										
20000										
25000										

Ground-To-Ground Propagation, Operation/Power Setting:

SlntDist(ft)										
A/C Type										
ACC/OPC										
RPM/EPR										
Knots										
200										
250										
315										
400										
500										
630										
800										
1000										
1250										
1600										
2000										
2500										
3150										
4000										
5000										
6300										
8000										
10000										
12500										
16000										
20000										
25000										

WORKSHEET 8

CALCULATION OF SLANT DISTANCE AND AIRCRAFT SEL AT SITES

Measurement Program________ Sheet __ of __

Site Number________________
Engineer________________
Date________________
Aircraft Type________________
Operation________________
Mission________________
Altitude Profile Code________________
Power Profile Code________________

	From Map			From Chronicle	
	Distances (feet)				
Site	Altitude	Lateral Distance	Downrange Distance	Noise Profile	Δ SEL

Use Eq. 1 in Supplement

	From Worksheet 7	NOISEFILE SEL + Δ SEL
Slant Distance	NOISEFILE SEL	Aircraft SEL

Use on Worksheet 9 or for AIRCRAFT SEL from NOISEFILE

Supplement to Worksheet 8

1. Slant distance (ft) = $\sqrt{\text{perpendicular distance (ft)}^2 + \text{altitude (ft)}^2}$,

   where the lateral distance is the perpendicular distance from the measurement site to the point of closest approach on the flight track.

2. Angle β in degrees = $\sin^{-1}\left(\dfrac{\text{altitude}}{\text{slant distance}}\right)$.

WORKSHEET 9
STEP-BY-STEP ESTIMATION OF THE RELATIVE IMPORTANCE OF OPERATIONS AT A SITE

Measurement Program________ Sheet __ of __

Site Number______________________

Engineer________________________

Date___________________________

From Worksheet 8					
Aircraft	Operation	Mission	Aircraft SEL	Day Operations	Night Operations

Use Equations in Supplement

Calculated			
Effective Numbers of Operations	Partial DNL	Rank Number	Total DNL Through Rank

Supplement to Worksheet 9

1. $$\text{Effective number of operations} = \left(\begin{matrix}\text{number of day}\\ \text{operations}\\ (0700\text{-}2200)\end{matrix}\right) + 10\left(\begin{matrix}\text{number of night}\\ \text{operations}\\ (2200\text{-}0700)\end{matrix}\right).$$

2. $$\text{Partial DNL} - \text{Aircraft SEL} + 10\log\left(\begin{matrix}\text{Effective}\\ \text{number of}\\ \text{operations}\end{matrix}\right) - 49.4.$$

3. $$\text{Total DNL through rank} = 10\log\left[\left(10^{DNL_1/10}\right) + \cdots + \left(10^{DNL_n/10}\right)\right],$$

where n is the rank number being calculated.

*U.S. Government Printing Office: 1980 — 757-002/267

SUPPLEMENTARY

INFORMATION

AD-A093948

AFAMRL-TR-80-45

ERRATA

Page 50, Equation 1 should read:

$$\sigma_i = N_i \left[\text{antilog } (SEL_i + \sqrt{VARIANCE_i})/10 - \text{antilog } (SEL_i/10) \right]$$

Page 58, Equation 3 should read:

$$c.i. = 10 \log \left[\text{antilog } (DNL(M)/10) \pm z_c \frac{\sigma_M}{m} \right]$$

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This errata sheet for AFAMRL-TR-80-45 supersedes the previous errata sheet that dealt with corrections to equations on pages 50 and 58. The equation on page 58 was changed with a square root of m instead of m in the denominator. Although the equation on page 47 gave the correct confidence intervals as they are printed, the intermediate step gave a wrong answer for σ_s. This σ_s is used later in page 53 to determine the probability of consistency of the DNL values.

If you have any questions regarding this errata sheet, feel free to contact me at AUTOVON 785-3664 of commercial (513) 255-3664.

Robert A. Lee

ROBERT A. LEE
Biodynamic Environment Branch
Biodynamics & Bioengineering Div

ERRATA

Page 50, Equation 1 should read:

$$\sigma_i = N_i \left[\text{antilog } (SEL_i + \sqrt{VARIANCE_i})/10 - \text{antilog } (SEL_i/10) \right]$$

Page 58, Equation 5 should read:

$$c.i. = 10 \log \left[\text{antilog } (DNL(M)/10) \pm z_c \sigma_M / \sqrt{m} \right]$$

Page 47, Equation 2 should read:

$$\sigma_s = \frac{1}{86,400} \sqrt{\sum_{i=1}^{n_i} N_i^2 \sigma_i^2}$$

and Equation 3 should read:

$$c.i. = 10 \log \left[\text{antilog } (DNL(S)/10) \pm Z_c \sqrt{\sum_{i=1}^{n} N_i^2 \sigma_i^2 / n} \right]$$

or

$$c.i. = 10 \log \left[\text{antilog } (DNL(S)/10) \pm Z_c \sigma_s / \sqrt{n} \right]$$